Deloitte & Touche

THE COMPETITIVE ENTERPRISE

AN EXECUTIVE'S GUIDE TO INVESTING IN ADVANCED MANUFACTURING AND PROCESSING TECHNOLOGY

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TABLE OF CONTENTS

	Page
PREFACE	i
THE PURPOSE OF THIS GUIDE	i
WHAT IS ADVANCED MANUFACTURING AND PROCESSING TECHNOLOGY (AMT)?	i
WHY IS THIS GUIDE NEEDED?	ii
WHO SHOULD USE THIS GUIDE?	ii
HOW DO I USE THIS GUIDE?	ii
HOW THIS GUIDE WAS DEVELOPED	iii
INTRODUCTION	1
INFLUENCES ON MANUFACTURING AND PROCESSING IN THE 1990s	1
IMPLICATIONS FOR CANADIAN MANUFACTURERS AND PROCESSORS	5
USING AMT FOR COMPETITIVE ADVANTAGE	5
YOU MUST BE COMMITTED TO AMT	6
A "HOW-TO" APPROACH TO AMT INVESTMENT	8
PHASE I: IDENTIFY POTENTIAL AMT APPLICATIONS	11
STEP 1 - PERFORM A SELF-ASSESSMENT	16
STEP 2 - IDENTIFY YOUR COMPANY'S GOALS	22
STEP 3 - RANK YOUR COMPANY'S GOALS	24
STEP 4 - ASSESS YOUR COMPANY'S NEEDS	26
STEP 5 - IDENTIFY WHICH AMTs WILL BEST HELP YOU COMPETE	29
STEP 6 - IDENTIFY SPECIFIC AMT APPLICATIONS	32
PHASE II: EVALUATE AMT ALTERNATIVES	37
STEP 7 - GATHER DETAILED INFORMATION	40
STEP 8 - PERFORM AN ECONOMIC COST/BENEFIT ANALYSIS	46
STEP 9 - EVALUATE ALTERNATIVE AMT APPLICATIONS	52
STEP 10 - MAKE THE DECISION	62
PHASE III: SELECT THE AMT SUPPLIER	63
KEY SUCCESS FACTORS	63
SUGGESTED STEPS FOR THE SELECTION PROCESS	66

TABLE OF CONTENTS (Cont'd)

	Page
PHASE IV: IMPLEMENT THE AMT	69
KEY SUCCESS FACTORS	69
SUGGESTED STEPS FOR THE IMPLEMENTATION PROCESS	72
PHASE V: ASSESS YOUR AMT INVESTMENT	75
STEP 11 - DETERMINE WHEN TO CONDUCT PERIODIC REVIEWS	77
STEP 12 - CONDUCT PERIODIC REVIEWS	80
STEP 13 - TRACK YOUR PERFORMANCE AFTER EACH REVIEW	83
GLOSSARY OF AMT TERMS	89
ACKNOWLEDGEMENTS	95
APPENDICES	
A. AMT Applications for Six Industry Groupings	A.1
B. AMT Economic Analysis - Benefits Detail Worksheets	B.1
C. AMT Economic Analysis - Cost Detail Worksheets	C.1
D. AMT Economic Analysis - Cost/Benefit Summary Worksheet	D.1

LIST OF EXHIBITS

Exhibit	Title	Page
1	A How-To Approach to AMT Investment	9
2	Phase I - Identify Potential AMT Applications	12
3	Steps 1, 2, and 3 - Self-Assessment	17
4	Step 4 - Assess Your Company's Needs	27
5	Step 6 - Identify Specific AMT Applications	34
6	Phase II - Evaluate AMT Alternatives	39
7	Step 7 - Gather Detailed Information	41-43
8	Step 9 - Final Evaluation Table	54
9	Step 9 - Evaluation Scale Definitions	58
10	Step 9 - Evaluation Commentary Sheet	59
11	Phase III - Select the AMT Supplier	64
12	Phase IV - Implement the AMT	70
13	Phase V - Assess Your AMT Investment	76
14	Steps 11, 12 and 13 - Performance Tracking Table	78
15	Steps 11, 12 and 13 - Performance Tracking Graph	79

LIST OF CASE EXAMPLES FOR NEW TIMBER, INC.

Case Example	Title	Page
A	New Timber Income Statement	14
B	Self-Assessment - Part 1	20
C	Self-Assessment - Part 2	23
D	Self-Assessment - Part 3	25
E	Assess Your Company's Needs	28
F	List of AMT Applications	31
G	Benefit and Cost Calculations	48-49
H	Cost/Benefit Summary	50
I	Final Evaluation Table - Part 1	56
J	Final Evaluation Table - Part 2	61
K	Performance Tracking Table	85
L	Performance Tracking Graph	86

PREFACE

THE PURPOSE OF THIS GUIDE

This guide is about competitiveness in manufacturing and processing. It focuses on Advanced Manufacturing and processing Technology (AMT), a key means by which Canadian manufacturers and processors can improve their performance in an increasingly competitive world. The guide will help senior management in small and medium-sized enterprises make informed decisions about investing in AMT for their business. For the purposes of this guide, AMT includes those technologies that can be applied both in the manufacturing and processing industries.

To help executives make their AMT investment decisions, this guide provides an inexpensive, comprehensive, step-by-step method to assist in identifying, evaluating and implementing AMT. However, while the guide presents a simple approach to investing in AMT, the actual process of identifying, assessing, choosing and implementing worthwhile AMT investments is recognized to be complex and time-consuming.

WHAT IS ADVANCED MANUFACTURING AND PROCESSING TECHNOLOGY (AMT)?

Advanced Manufacturing and Processing Technology is the collection of computer hardware, software and telecommunications products that enable employees to do their jobs more effectively and companies to produce products more efficiently.

Some AMT examples include:

- computer aided design (CAD)
- computer aided manufacturing (CAM)
- bar coded data collection
- computer numerical control machines (CNC)
- robots and semi-automated machinery
- computer modelling and simulation
- expert systems
- electronic data interchange (EDI).

However, this guide excludes office technologies such as:

- accounting systems
- word processing and desktop publishing
- telephones/facsimile machines
- voice mail and cellular telephones.

WHY IS THIS GUIDE NEEDED?

This guide serves a variety of needs. It will:

- help you identify and prioritize possible AMT applications
- provide a practical approach to determining the value of AMT investments
- help link AMT investments to your company's business plan
- help build a business case to take to your banker or investor
- identify benefits that enhance your company's competitive position
- demonstrate that AMT is no longer just for the "big players".

WHO SHOULD USE THIS GUIDE?

This guide is for executives, chief executive officers (CEOs) or presidents of small and medium-sized enterprises (SMEs) in Canadian manufacturing, processing and goods producing industries. CEOs or presidents are usually responsible for the final decision to invest in new systems and, to a large extent, for the systems' final selection and implementation. However, regardless of their title, we call people who hold these responsibilities "champions" of AMT in their own organizations. This concept is further developed in the Introduction.

HOW DO I USE THIS GUIDE?

It would be unreasonable to expect the CEO or president to perform every detail of every step in this guide. Our experience has shown that the most effective method of using this guide is to set up a small management team, work through a few steps, delegate some fact finding, meet again to review the findings, have your financial person do some "number-crunching", and evaluate the alternatives as a team.

As you review the guide, set a plan of action, decide whom you want to involve, at what stages of the process, and when you will meet. You may also wish to seek expert advice

from an independent specialist. This approach will ensure that the correct level of delegation is set, and that more than just the CEO or president is involved.

HOW THIS GUIDE WAS DEVELOPED

This guide was developed using the following approach:

- Research and Writing: The guide was compiled using data on methods of evaluating AMT investments, selecting equipment and conducting post-implementation reviews together with the previous experience of Deloitte & Touche Management Consultants.

- Panel of Experts Challenge: A panel of experts validated the method and provided input on the reader's information needs. The panel included manufacturers and processors from the target industries which already use AMT, industry representatives, suppliers and experts in designing and implementing AMT.

- Case Study Approach: The guide presents a practical, easy-to-use approach. A case study example of a fictitious producer of hardwood sliced veneer illustrates the AMT decision-making process.

- Pilot Site Testing: The guide was tested in 10 companies that either recently invested in AMT or will do so in the near future. This pilot test brings a real life perspective to the guide, ensuring that it is practical and useful.

- Sponsor Input: Input from Industry, Science and Technology Canada, the guide's sponsor, was included throughout the process.

INTRODUCTION

INFLUENCES ON MANUFACTURING AND PROCESSING IN THE 1990s

During the 1990s, the environment in which Canadian manufacturing and processing industries operate will change significantly. Some external influences will represent opportunities; others will be threats. These influences must be understood and acted upon if industries are to prosper in the 1990s. This introduction briefly examines some of these influences in the areas of:

- economic environment
- demographics and lifestyles
- environmental changes
- technology
- customers
- suppliers
- competitors.

Economic environment

The global business environment will become more turbulent and competitive as this decade progresses. Canadian manufacturers and processors will be challenged by a variety of economic and political factors. Some of these factors include the unification of the European Common Market in 1992 into a single trading bloc, the further growth of competitive businesses in Japan and Southeast Asia and the emergence of South American and, possibly, Eastern European manufacturers and processors as global competitors. As a result, Canadian businesses must address several key issues. These issues include:

- dominance of major trading blocs: the European Community, North America, Japan and Asia
- globalization of markets and production
- increasing difference in factors of production among Canada, the United States and Mexico.

Demographics and lifestyles

Over the next decade, Canadian manufacturing and processing industries will face significant challenges in both the size and skills of their domestic labour supply. The changing population will also create demands for different consumer product demands.

Labour Aspects

The labour implications of these demographic changes include:

- greater competition for graduates and a shift to more flexible working hours and part-time working arrangements
- higher labour unit (wage) costs
- shortages of skilled and semi-skilled labour
- increased labour and skill substitution through automation and expert systems.

Consumer Aspects

The consumer implications of the demographic changes include:

- growth and change in markets resulting from an increasing proportion of retired and elderly people in many countries
- growth in markets for high quality goods
- a switch towards healthier and more environmentally positive products.

Environmental changes

Historically, the natural environment has received little attention as a component in manufacturing or processing. Today, there is an increasing awareness of the natural environment and concern about the effects of pollution, energy consumption and depletion of natural resources. Some implications for manufacturers and processors include:

- the need to be aware of environmental legislation and consumer pressures
- changes in materials and product design that make products less damaging to the environment and more energy efficient
- the innovative use of new materials, reduction of waste and better treatment of waste.

Technology

Technology alone does not drive industrial development, though it is a vital ingredient. Rapid technological advances are enablers for business development. Factors to be considered include:

- technology's increasing use as a major enabler of competitive advantage, achieved by incorporating technological developments in new and differentiated products and by using new technology in manufacturing or processing
- the fact that technologies important to the vast majority of Canadian manufacturing and processing companies over the next 10 years are already known; of particular importance is the application of existing technologies, many of which may need to be imported
- embedded technologies, such as microprocessors, which will play an increasingly important role at the product level.

Customers

Markets, products and services are, for the most part, consequences of other factors, in particular world economic, demographic and lifestyle trends. The issues to be considered include:

- the global market's polarization into three major groupings: North America, Europe and Japan/Pacific
- Mexico and South America are becoming important consumers of world goods
- innovation, which will require advanced technologies to help differentiate products

- product life cycles which will become shorter, pushed by new technological developments and pulled by consumer demand.

Suppliers

"Make versus buy" is becoming a critical issue in the 1990s. Many manufacturing and processing companies are both suppliers to, and customers of, other companies. The major implications of this include:

- the supply of certain key technologies becoming dominated by a limited number of large, powerful, global businesses
- a concentration on core activities, with other activities contracted out
- the development of alliances and partnerships, based on sharing risk and mutual strength.

Competitors

Canadian manufacturers and processors have faced increasingly intense competition over the past 20 years. Studies released by the Canadian Manufacturers' Association indicate that Canada's competitive position, relative to the world's six largest industrialized nations, has steadily diminished over the last decade, because;

- relatively high interest and exchange rates pose a threat to many small Canadian manufacturers and processors
- consumers around the world generally purchase products for their quality and service, not their price or national origin
- many businesses use speed as a competitive weapon--introducing new products quickly through rapid and responsive manufacturing and distribution.

IMPLICATIONS FOR CANADIAN MANUFACTURERS AND PROCESSORS

Four major themes arise when considering the influences that will affect Canadian manufacturers and processors in the 1990s. These are summarized as follows:

- **EXPECT MORE COMPLEXITY:** More advanced technologies in the product, wider product ranges, customization, more component variety and more customers.

- **EXPECT MORE UNCERTAINTY:** A wider range of customers, shorter product life cycles, more product choice, volatile exchange rates, changing interest rates and more political changes.

- **THINK GLOBAL:** Even though your business may not be global, some of your competitors and suppliers may be targeting global markets today.

- **THINK EXCELLENCE:** Standards of customer satisfaction will increase, as will competition. Companies will be expected to meet exacting standards of quality, delivery and cost in increasingly difficult circumstances. Excellence is the only way to describe the total performance required.

USING AMT FOR COMPETITIVE ADVANTAGE

Canadian manufacturers and processors must respond to the threats and opportunities they face. They must quickly produce the variety of quality products their customers expect, and do so at the right price. To remain competitive, there are several key business initiatives to consider including:

- integrate and innovate your factory
- apply information and advanced manufacturing technology
- attract, train and retain skilled employees
- develop innovative products
- produce a commodity product at the lowest possible cost
- improve customer service
- market products and services through the use of AMT
- consider strategic partnerships.

AMT is changing the way companies operate. It affects the entire process by which they create their products. Furthermore, it is reshaping the product itself--the entire package of goods, services and information that companies provide to create value for their customers.

Many Canadian companies have successfully adopted and implemented AMT which continues to provide them with an advantage over their domestic and foreign competitors. Successfully investing in AMT has a powerful effect on a company's competitive advantage, as measured by indicators of competitiveness such as:

- increased efficiency
- greater flexibility
- improved quality and service
- higher level of innovation
- greater dependability.

There is clearly a high level of interest in AMT. However, the stakes are high and the risks are very real. Unfortunately, the fear of losing competitive position or possible threats to their survival have resulted in some companies taking on short-sighted projects that did not match their long-term business strategy.

The biggest risk a company can take is to jump into AMT without conducting a thorough analysis of its business. It is the *strategic use of technology* that produces gains for a company, not the technology itself.

YOU MUST BE COMMITTED TO AMT

AMT is not a cure for all problems. It cannot fix inattentive customer service, poor quality management or poor relations with suppliers. However, many Canadian manufacturers and processors have found AMT does help their companies to meet targets for survival, profit and growth.

This guide is designed to help you consider and evaluate AMTs that could benefit your business. However, without your participation and commitment, the guide alone will do nothing. In virtually every case where AMT has been successfully installed, two underlying themes have been evident.

A commitment to action

Sound business decisions can only be made on the basis of well-researched facts. Implementing technology requires a significant effort from you and your staff. It will change the structure of your organization, its procedures and products and people's job responsibilities. However, this will not happen successfully unless there is a major commitment to action from the president, CEO and business owner.

The need for a "champion"

Unless you, the president or CEO, take on a strong role of either "championing" or supporting the "champion" of AMT within your business, it is highly unlikely that your AMT project will be successful. The champion is someone who does not take "no" for an answer. A champion is someone who takes whatever steps are necessary to keep the idea moving toward implementation. Champions must also hold a level of authority that allows them to make decisions and act on them decisively, and must possess a good understanding of the production process. They need to be informed so they may take the necessary calculated risks on AMT that will provide the firm with the promised benefits.

In many successful AMT implementations, a "leap of faith" was necessary to get the project started. If this faith is to be shared by the entire company, it must start at the top level within the organization.

It has been our experience that a team approach, with the champion as team leader, is an effective means of gaining the commitment of the company. It is also the recommended approach to tackling the method in this guide.

A "HOW-TO" APPROACH TO AMT INVESTMENT

This guide is designed to help champions identify potential AMT applications that support their businesses' long-term plans. It examines methods of evaluating and choosing technology applications, selecting the AMT supplier and implementing the chosen technology. It is a "how-to" guide that uses a case study of a veneer manufacturer to illustrate the five phases to be followed in the decision process. These phases, shown in Exhibit 1, are:

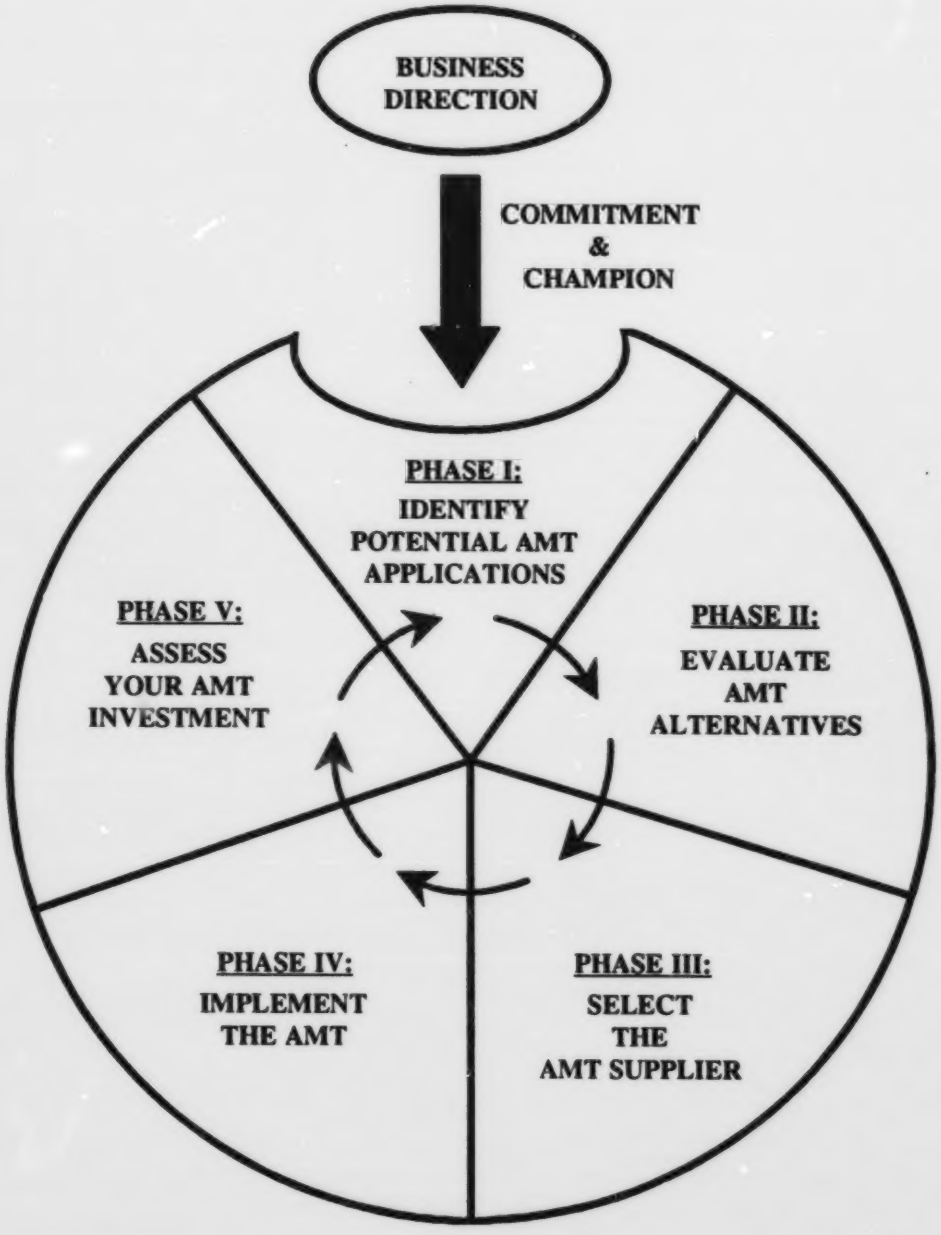
- I Identify Potential AMT Applications
- II Evaluate AMT Alternatives
- III Select the AMT Supplier
- IV Implement the AMT
- V Assess Your AMT Investment.

This process will not guarantee success. However, it does provide a step-by-step method to help ensure that your potential AMT applications are identified and properly evaluated, thereby minimizing their risk. AMT has been implemented successfully many times, and this guide builds on the lessons learned the "hard way". These lessons include the need to:

- establish realistic expectations
- establish a broad awareness of technology issues and needs among key staff
- co-ordinate technology investments to support your long-term business plan
- link technology decisions to market requirements
- allocate resources purposefully and concentrate efforts
- exploit existing technologies fully
- simplify first, refine the requirements next, then automate and finally integrate.

Exhibit 1

A "HOW-TO" APPROACH TO AMT INVESTMENT


BUSINESS DIRECTION
COMMITMENT & CHAMPION
PHASE I: IDENTIFY POTENTIAL AMT APPLICATIONS
PHASE II: EVALUATE AMT ALTERNATIVES
PHASE III: SELECT THE AMT SUPPLIER
PHASE IV: IMPLEMENT THE AMT
PHASE V: ASSESS YOUR AMT INVESTMENT

This guide is structured in the following manner:

PHASES

STEPS

ACTIONS

Phase I discusses the process of identifying potential AMT applications that should then be evaluated in detail. Many companies have already identified several applications or projects for detailed analysis. These applications may have been selected on the basis of knowledge of the industry, moves already made by competitors or the need to make immediate changes in a particular part of the production process. However, because some of the detailed evaluation criteria draw upon steps described in this phase, all readers are recommended to work through Phase I.

It should be emphasized that this guide is not intended as a "quick read". Without making a realistic investment in thought and effort, a guide of this kind will only be of limited value.

PHASE I: IDENTIFY POTENTIAL AMT APPLICATIONS

Many presidents or CEOs of small- and medium-sized businesses are aware of the need to consider AMT applications for their factory processes. While some have already implemented at least one AMT application, others have not implemented AMT in any form. Few have a defined method to ensure that they identify, evaluate and match potential applications to their businesses' long-term strategies. Some reasons for this lack of investment in AMT include:

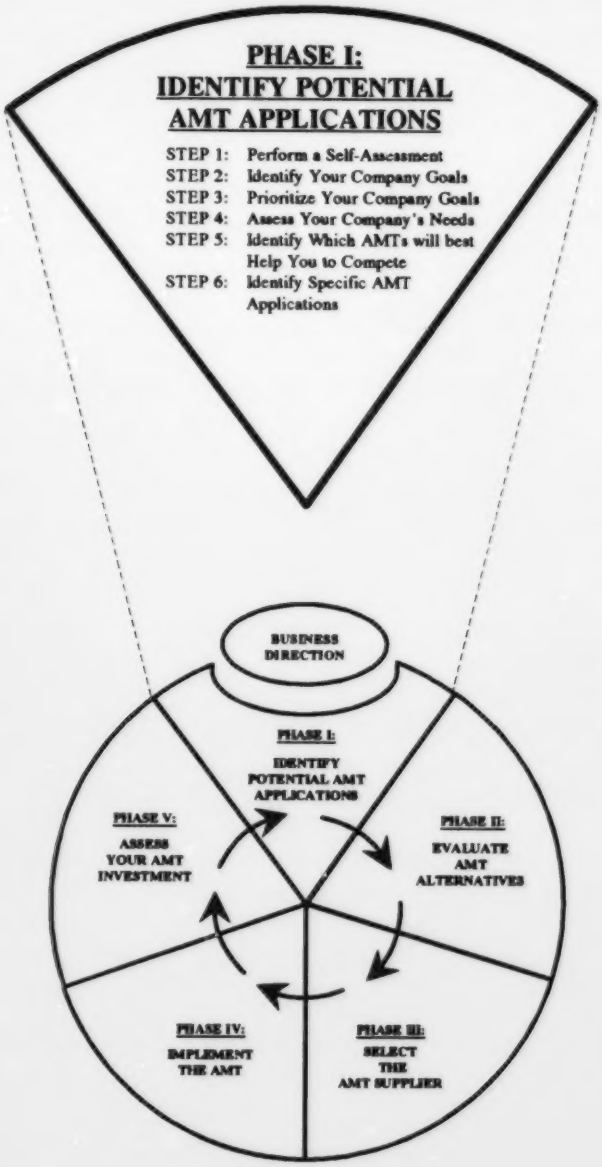
- a lack of knowledge about and time to research new technology
- a lack of operator/worker/supervisor acceptance of new technology
- the significant cost of implementing new technology
- the many reports of companies that were not successful with AMT
- the difficulty of justifying new technology projects on economic grounds.

Phase I outlines the steps (shown in Exhibit 2) by which potential AMT applications are identified. Each application is considered on its ability to contribute to the company's long-term business plan. This phase assumes that the company has:

- developed a business plan and has defined its core business, goals, products and services
- clearly identified the manufacturing or processing resources (i.e. equipment, facilities, manufacturing/processing systems and human resources) that are critical to supporting its business plan
- defined the levels of manufacturing/processing capacity, capability and performance required by its business plan
- assessed the strengths and weaknesses of its current resources.

Exhibit 2

PHASE I
IDENTIFY POTENTIAL AMT APPLICATIONS


PHASE I:
IDENTIFY POTENTIAL AMT APPLICATIONS
STEP 1: Perform a Self-Assessment
STEP 2: Identify Your Company Goals
STEP 3: Prioritize Your Company Goals
STEP 4: Assess Your Company's Needs
STEP 5: Identify Which AMTs will best Help You to Compete
STEP 6: Identify Specific AMT Applications
BUSINESS DIRECTION
PHASE I: IDENTIFY POTENTIAL AMT APPLICATIONS
PHASE II: EVALUATE AMT ALTERNATIVES
PHASE III: SELECT THE AMT SUPPLIER
PHASE IV: IMPLEMENT THE AMT
PHASE V: ASSESS YOUR AMT INVESTMENT

In this phase, you will assess your company based on five key indicators of competitiveness and consider what you want your company to achieve in each area. The guide provides a list of potential AMT applications for your particular industry based on your prioritized goals. You will then list the shop floor processes within your company and identify any problems which may hinder your company in meeting its goals. Finally, you will ensure that the available AMT applications will resolve the problems identified. **By the end of this phase, you will have a short list of potential AMT applications for your business.**

This guide's method is best illustrated through a case study. In this study, Robin Miller is the president and CEO of New Timber Inc. Faced with fierce, low-cost foreign competition that can produce products of comparable quality, Miller is considering investing in AMT to help reduce throughput times, increase New Timber's cost competitiveness, improve manufacturing flexibility and increase product quality, all to enable the company to better meet customers' specific needs.

Each step of this guide will be illustrated using the case of New Timber Inc. and Robin Miller's decision-making process. By following Miller's progress through the various steps, you will be in a better position to develop your own short list of potential AMT applications for your business. These will then be evaluated in Phase II.

THE CASE OF NEW TIMBER INC.

New Timber Inc. is a medium-sized manufacturer of hardwood sliced veneer. The company is the major employer in the northern Ontario town in which it is located. New Timber Inc.'s financial performance is summarized in Case Example A.

CASE EXAMPLE A

NEW TIMBER, INC.
INCOME STATEMENT ($000s)

	1988	1989	1990
Sales	$27,875	$29,825	$31,910
Cost of Goods Sold			
Cost of Raw Materials	13,937	14,912	15,955
Direct Labour Cost	6,967	7 455	7,977
Other Costs	4,180	4,475	4,787
Gross Margin	2,791	2,983	3,191
Selling and Admin. Expenses:	1,395	1,490	1,595
Operating Profit	1,396	1,493	1,596
Other Revenue	1,000	1,000	1,000
Income Before Tax	2,396	2,493	2,596
Provisions for Income Tax	838	872	908
Net Income	$1,558	$1,621	$1,688

New Timber faces increasing international market pressure. The company's president, Robin Miller, knows that introducing more cost-effectiveness measures to the company are critical to its long-term success. Miller is aware that foreign competitors have already introduced state-of-the-art AMT. Miller is anxious to introduce AMT at New Timber, which will further reduce its costs and improve its yield and product quality.

Miller also acknowledges the strength of the employees' union, and knows that changes will have to be introduced in a way that the union finds acceptable. In Miller's mind, forced change, which workers might perceive as a threat, will inevitably fail.

The Product

Veneer is a very thin layer of wood of uniform thickness that is produced by peeling, slicing or sawing logs, or flitches. Sliced veneer is the most sought after type of veneer for use in expensive furniture and panelling. Sliced veneer can also be laminated to one or both sides of plywood sheets. While there are thousands of suitable hardwood species around the world, New Timber concentrates on Canadian hardwoods, such as maple, birch and red oak, among others. The company also cuts imported logs, such as teak and mahogany, and provides a custom cutting service on request.

Veneer can be sliced in a variety of thicknesses. Export customers prefer the thinnest veneer for its flatness, ease of use and lower shipping costs. Thinner slicing generates higher yields, in terms of square feet of veneer per board foot of lumber, so more high quality logs are cut for export for which higher prices can be obtained. Demand is also increasing for flatter, smoother veneer which requires greater than normal care to manufacture or process.

The Competition

Miller is aware that several of New Timber's international competitors, primarily those in Australia and New Zealand, have recently adopted state-of-the art manufacturing equipment. These companies are beginning to match the quality of products that New Timber produces. Because veneer is largely a commodity market at the low end, Miller knows that these competitors are attempting to displace New Timber from the protected high quality niche that it has enjoyed for five years.

Robin Miller's Vision

Miller sees New Timber as a leading producer of highest quality, specialty hardwood veneers in North America. Miller exports close to 35 percent of annual production, mostly to the U.S. Other export clients are located in South East Asia, Japan and Western Europe. Miller also recognizes the potential to export New Timber's products to Eastern Europe and hopes to realize a slice of this relatively young market.

Miller is intent on defending New Timber's particular market niche and in further expanding international sales. The only way the company can continue the growth it has enjoyed in the past is to consider some form of AMT that might help it increase its now threatened market share.

Because this will be the company's first experience with any type of AMT, Miller wants to consider carefully a broad range of AMTs. Miller wants to be certain of identifying the particular application that will best meet the company's needs and help realize the medium- and long-term business objectives.

STEP 1 - PERFORM A SELF-ASSESSMENT

This self-assessment is designed to allow you to assess your company's position in relation to your competition in Canada or elsewhere. The assessment should be realistic and based on your company's current position, rather than on future expectations. As mentioned earlier, the team approach is recommended here.

ACTION:
ASSESS YOUR COMPANY'S CURRENT POSITION

Exhibit 3 provides a table of key indicators of competitiveness. Assess your company's current position within your present market (be it local, national or international) by rating it on a scale between 1 and 5 for each indicator. The ratings are:

1 = Your company is well below the average for your industry

2 = Your company is among those below average for your industry

3 = Your company is average for your industry

4 = Your company is among those above average for your industry

5 = Your company is an industry leader.

For each indicator, record your company's current position on Exhibit 3 with an "X". Two examples may help to illustrate this rating system.

The first example concerns a small, unautomated, custom plastics extruder. This company must compete with much larger firms that are able to significantly undercut production costs and product prices. The larger companies have also eclipsed the smaller manufacturer's former advantage of providing quality products. The larger competitors appear to be able to produce higher quality with greater efficiency through the use of AMT. AMT helps them eliminate labour-intensive tasks and provides them with the necessary flexibility to produce high quality custom plastics, using a wider variety of resins.

Clearly, the small manufacturer has critical problems regarding efficiency, production costs and maintaining product quality. The company must take immediate action if it is to remain competitive. Otherwise, it risks eventual elimination at the hands of its larger rivals. In this example, the company's rating for the "Efficiency" indicator of competitiveness would be "1" because it faces a critical concern that must be resolved. The company's rating for the "Quality" indicator of competitiveness would be "2".

DATE _____

STEPS 1, 2 & 3 - SELF-ASSESSMENT

INDICATOR OF COMPETITIVENESS		STEPS 1&2 RATING 1	2	3	4	5	STEP 2 SHORT TERM SPREAD	STEP 2 LONG TERM SPREAD	STEP 3 PRIORITY RANKING (1-5)
EFFICIENCY	CURRENT POSITION								
	PREFERRED POSITION								
FLEXIBILITY	CURRENT POSITION								
	PREFERRED POSITION								
QUALITY	CURRENT POSITION								
	PREFERRED POSITION								
INNOVATION	CURRENT POSITION								
	PREFERRED POSITION								
DEPENDABILITY	CURRENT POSITION								
	PREFERRED POSITION								

KEY

X = Current
Y = Short Term Goal
Z = Long Term Goal

RATINGS

1 = Your company is well below the average for your industry
2 = Your company is among those below average for your industry
3 = Your company is average for your industry
4 = Your company is among those above average for your industry
5 = Your company is an industry leader

INSTRUCTIONS:

STEP 1 - Place an "X" at the appropriate rating for each of the 5 indicators in the "CURRENT POSITION" row.

STEP 2 - Place a "Y" and "Z" at the appropriate rating for each of the 5 indicators in the "PREFERRED POSITION" row.
- Calculate the short and long-term spreads.

STEP 3 - Assign the priority rankings (1-5).

Exhibit 3

The second example is of a medium-sized Canadian pulp manufacturer that primarily produces specialty pulps; the company is also an industry leader in R&D. The company has historically developed new types of pulp to meet its largest customers' specific needs. It has also been able to treat its effluent in a new, innovative way that allows the company to resell what was formerly a useless by-product. The company is committed to remaining on the forefront of R&D and maintaining its image as an innovative market leader.

However, the company is aware that a major competitor is on the brink of duplicating several of its proprietary processes. The pulp manufacturer's rating for the "Innovation" indicator of competitiveness would be "4"; the company is doing well but it does face a potential competitive threat and must therefore continue to improve.

An explanation of the indicators of competitiveness used in the table are as follows:

Efficiency

Efficiency would be a primary indicator of competitiveness for manufacturers or processors of commodity products, where customers are extremely price-sensitive and do not differentiate between products on the basis of their producer. Some components of efficiency include:

- unit cost (for volume manufacturers/processors)
- overall plant productivity
- labour productivity
- machine utilization factors
- efficiency, in terms of lead time and throughput time
- purchasing, inventory and work-in-progress management and control
- operating costs.

Flexibility

Flexibility would be a primary indicator of competitiveness for manufacturers or processors that produce smaller batches of highly differentiated products which cater to customers' specific needs or are manufactured or processed to custom specifications. Some components of flexibility include:

- ability to meet short lead times
- ease of accommodating design changes
- ability to reduce set-up times

- ability to produce smaller batch sizes economically.

Quality

Quality would be a primary indicator of competitiveness in industries where customers demand quality and make their purchasing decisions based on a given product's degree of perceived quality. Some components of quality include:

- statistical process control
- consistent and reliable product output
- improved product design
- low product rework, damage and scrap.

Innovation

Innovation would be a primary indicator of competitiveness in highly competitive industries where product life cycles are short and market demands continually change.
Some components of innovation include:

- differentiation through style or quality
- creation of a company image
- competitive advantage
- use of strategic alliances to pool creative resources.

In addition, process innovation should not be overlooked. Any innovative means of speeding up, simplifying or reducing inputs in the manufacturing process should be considered.

Dependability

Dependability would be a primary indicator of competitiveness for manufacturers or processors whose customers demand just-in-time product delivery. Some components of dependability include:

- reliability of service to the customer
- quick customer response times
- consistent product quality
- sufficient spares and backup.

Based on Miller's own perception of New Timber, the table presented in Exhibit 3 was used to rate the company's current competitiveness. The result is presented in Case Example B:

CASE EXAMPLE B

SELF-ASSESSMENT - PART 1
NEW TIMBER INC.

INDICATOR OF COMPETITIVENESS		STEPS 1&2 RATING 1	2	3	4	5	STEP 2 SHORT TERM SPREAD	STEP 2 LONG TERM SPREAD	STEP 3 PRIORITY RANKING (1-5)
EFFICIENCY	CURRENT POSITION		X						
	PREFERRED POSITION								
FLEXIBILITY	CURRENT POSITION		X						
	PREFERRED POSITION								
QUALITY	CURRENT POSITION			X					
	PREFERRED POSITION								
INNOVATION	CURRENT POSITION				X				
	PREFERRED POSITION								
DEPENDABILITY	CURRENT POSITION				X				
	PREFERRED POSITION								

Efficiency

New Timber is no longer able to produce high quality veneer at competitive prices, which customers had come to expect. The company's production costs, relative to those of its competitors, have increased markedly. Miller believes this is because New Timber's equipment is inefficient compared to the new AMT utilized by the offshore competitors. In fact, Miller even feels the machines New Timber installed just five years ago are now antiquated. Miller also believes that New Timber's labour costs are higher than its competitors. This is due to the amount of manual labour the process requires, a high minimum wage and a strong union. Finally, because New Timber produces custom veneer, its production runs are very short and the down time during change-overs represents a significant inefficiency.

Flexibility

New Timber's manufacturing flexibility is constrained as a result of old equipment. Changeovers and manual recalibration of machinery require costly downtime and wastage. In order to continue producing a large variety of veneer to exacting client specifications New Timber will have to realize increased flexibility in its manufacturing process.

Quality

New Timber has an excellent international reputation for producing high quality specialty hardwood veneer to exacting specifications. However, many international customers are demanding thinner veneers. Demand is also increasing for flatter, smoother veneers which requires greater than normal care to manufacture.

Miller is aware that New Timber is unable to produce high quality thinner veneer on its current equipment. The company could not consistently produce veneers of that quality without a significant amount of rework and wastage. However, New Timber's competitors seem able to produce veneer to exacting customer specifications at a reasonable cost. Miller realizes that, to preserve New Timber's current customer base and enhance its international reputation, the company must maintain the quality of its products.

Innovation

Historically, New Timber has been responsive to its customers' needs. The company went to great lengths to satisfy specific customer requests for custom veneer. It worked with several customers to develop new types of veneer made from different species of wood to exacting specifications. All of this enhanced New Timber's international reputation. Unfortunately, that reputation is costly to maintain because New Timber spends a great deal of time and money developing veneers with a customer before actually making a sale.

Dependability

New Timber has a solid reputation for customer service, one which Miller is keen to maintain. The company has a good record of timely delivery to its international customers and it works hard to address and respond quickly to customer concerns.

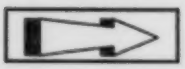
STEP 2 - IDENTIFY YOUR COMPANY'S GOALS

After assessing your company's current position in terms of the five key indicators of competitiveness, determine your objectives for these indicators in both the short- and long-term. Your company's goals have probably already been identified (formally or informally) in your business plan. (While this guide addresses issues in which AMT can play a significant role, they are only a subset of the issues considered when preparing the business plan.)

ACTION:
DETERMINE AND NOTE YOUR SHORT- AND LONG-TERM GOALS

The time horizons that differentiate short- and long-term goals will vary depending on your company and the industry in which it operates. For example, some food processors may consider a three-year horizon to be long-term. On the other hand, a machinery manufacturer may consider three years to be short-term.

Definitions of short- and long-term goals are probably provided in your business plan. However, as a general rule of thumb, goals are usually considered on two horizons: those you wish to achieve in two years, and in five years. Using the self-assessment table in Exhibit 3, mark your short- and long-term goals on the "Preferred Position" row. Use a "Y" for your short-term goals and a "Z" for the long-term ones.



ACTION:
CALCULATE SHORT- AND LONG-TERM SPREADS

By measuring and comparing the short- and long-term spreads between your current and preferred positions on the self-assessment table, you can determine the distance required to move from your current position to your future goal. Your short-term position will probably be based on current concerns and problem areas on the shop floor. Your long-term position will be more closely aligned to your business goals. This may help you determine the priority rankings.

On the self-assessment table in Exhibit 3, measure the distance between your current position ("X") and your short-term goals ("Y") by counting the squares between X and Y. Mark this number in the column entitled "Short-term Spread". The long-term spread is calculated in a similar manner, using the X and Z ratings.

Miller considered New Timber's competitive position, assessed it against management's corporate objectives and then calculated the short- and long-term spreads, as shown in Case Example C.

CASE EXAMPLE C

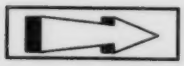
SELF-ASSESSMENT - PART 2
NEW TIMBER INC.

		STEPS 1&2 RATING					STEP 2		STEP 3
INDICATOR OF COMPETITIVENESS		1	2	3	4	5	SHORT TERM SPREAD	LONG TERM SPREAD	PRIORITY RANKING (1-5)
EFFICIENCY	CURRENT POSITION		X				1	2	
	PREFERRED POSITION			Y	Z				
FLEXIBILITY	CURRENT POSITION		X				1	2	
	PREFERRED POSITION			Y	Z				
QUALITY	CURRENT POSITION			X			1	2	
	PREFERRED POSITION				Y	Z			
INNOVATION	CURRENT POSITION				X		1	1	
	PREFERRED POSITION					YZ			
DEPENDABILITY	CURRENT POSITION				X		0	1	
	PREFERRED POSITION				Y	Z			

Miller considers improving efficiency while continuing to offer superior quality products to customers as being critical to New Timber's survival and success. It is also essential that New Timber have flexibility in its manufacturing so it can economically produce the variety of high quality veneers its customers demand. Miller believes that the company's main competitors, who also produce custom veneers, enjoy greater efficiency than New Timber and have the manufacturing flexibility to produce specialty orders economically.

On the other hand, Miller knows that New Timber's reputation for innovative product development and dependability is the best in the industry. However, Miller is aware that such a competitive advantage can quickly erode if it is not properly maintained.

STEP 3 - RANK YOUR COMPANY'S GOALS



ACTION:
RANK THE FIVE INDICATORS OF COMPETITIVENESS

Rank the five indicators of competitiveness on the basis of your current situation. To do this, you may have to choose between your short- and long-term horizons if they do not follow similar trends. Usually, the long-term direction is preferred. However, if you are in a position where immediate action is essential, using the short-term time frame may be more appropriate.

Use the spread between your current position and your short- and long-term goals to help prioritize the five indicators. The larger the distance between your current position and your goals, the greater the importance of accomplishing them.

Be sure to rank all five indicators. If two indicators appear to be equally important, make every effort to rank them anyway, using the spreads you have calculated.

Once the indicators have been ranked from 1 to 5, mark the rankings in the last column on the self-assessment table in Exhibit 3. If you are using an electronic spreadsheet model you may wish to re-sort these indicators on the basis of this ranking.

Miller ranked New Timber's corporate goals in order of priority, as shown in Case Example D:

CASE EXAMPLE D

SELF-ASSESSMENT - PART 3
NEW TIMBER INC.

INDICATOR OF COMPETITIVENESS		STEPS 1&2 RATING 1	2	3	4	5	STEP 2 SHORT TERM SPREAD	STEP 2 LONG TERM SPREAD	STEP 3 PRIORITY RANKING (1-5)
EFFICIENCY	CURRENT POSITION		X				1	2	2
	PREFERRED POSITION			Y	Z				
FLEXIBILITY	CURRENT POSITION		X				1	2	3
	PREFERRED POSITION			Y	Z				
QUALITY	CURRENT POSITION			X			1	2	1
	PREFERRED POSITION				Y	Z			
INNOVATION	CURRENT POSITION				X		1	1	4
	PREFERRED POSITION					YZ			
DEPENDABILITY	CURRENT POSITION				X		0	1	5
	PREFERRED POSITION				Y	Z			

Based on the vision of New Timber as a producer of high quality, custom veneers, Miller decided that ensuring quality was the most important company goal. It is critical to the company's continued survival and success. Efficiency was ranked second because the cost of producing high quality must nevertheless be reduced and controlled. With the abundance of competitors, customers are becoming less willing pay higher prices to cover the inefficiency of producing high quality products.

Flexibility in manufacturing is management's third priority. Miller feels that is critical to protecting New Timber's historic niche in the specialty market. It is also an important component in New Timber's ability to continue to develop new products with its customers. In addition, increased manufacturing flexibility will help reduce costs related to delays and wastage experienced during changeover.

STEP 4 - ASSESS YOUR COMPANY'S NEEDS

Now that areas requiring improvement have been identified at a broad level, consider your business processes in detail to identify the specific processes which cause your current problems or represent opportunities for improvement. Each of these processes is directly related to the realization of one or more of your company's goals identified in Step 3.

ACTION:
ITEMIZE AND LIST PROCESSES

Exhibit 4 has been designed to allow you to itemize the specific processes involved in your business under seven major categories:

- product design
- process planning
- material management/production control
- manufacturing or processing plant
- quality assurance
- product delivery/transportation and inventory
- other, for any other process.

Begin by listing your specific processes. Then, with your shop floor staff in either one-on-one interviews or group workshop sessions, identify any problems or areas for improvement in these processes. Determine whether resolving the problem will help fulfil your goals. For example, suppose you have a problem experienced with the tolerances (problem) on the planing machine (process). By solving that problem you will help improve the quality (indicator of competitiveness) of your products.

However, bear in mind that some problems cannot be solved through the use of AMT. For example, although AMT can help increase the yield of raw materials, it cannot change the unit cost. Similarly, AMT can reduce the number of labour hours required per product, but it cannot reduce the hourly wage rate for your labour.

Exhibit 4

DATE _____

STEP 4 -
ASSESS YOUR COMPANY'S NEEDS

MAJOR PROCESS	SPECIFIC PROCESS	PROBLEMS/ OPPORTUNITIES	INDICATOR OF COMPETITIVENESS SUPPORTED
1. PRODUCT DESIGN			
2. PROCESS PLANNING			
3. MATERIAL MANAGEMENT/ PRODUCTION CONTROL			
4. MANUFACTURING OR PROCESSING PLANT			
5. QUALITY ASSURANCE			
6. PRODUCT DELIVERY/ TRANSPORTATION & INVENTORY			
7. OTHER			

In the case of New Timber, Robin Miller itemized the specific processes involved in manufacturing veneer, and then arranged meetings with millworkers, millwrights, plant engineers and other employees within the company to discuss the list. Miller chose to meet with the employees in small groups. That provided the best forum for the candid exchange of ideas on the various problems encountered by different areas of the company which might be addressed through AMT applications. Miller then completed the table shown in Case Example E.

CASE EXAMPLE E

ASSESS YOUR COMPANY'S NEEDS
NEW TIMBER INC.

MAJOR PROCESS	SPECIFIC PROCESS	PROBLEMS/ OPPORTUNITIES	INDICATOR OF COMPETITIVENESS SUPPORTED
1. PRODUCT DESIGN	NEW PRODUCT DEVELOPMENT	· WASTE RESULTING FROM NEW PRODUCT DEVELOPMENT	EFFICIENCY QUALITY INNOVATION
2. PROCESS PLANNING	JOB SCHEDULING	· INABILITY TO PROPERLY SCHEDULE JOBS TO MINIMIZE DOWN-TIME FOR SET-UP	EFFICIENCY FLEXIBILITY
3. MATERIAL MANAGEMENT/ PRODUCTION CONTROL	RAW MATERIAL FLOW WORK-IN-PROGRESS FLOW	· WORK-IN-PROGRESS BOTTLENECKS · DAMAGE TO VENEER WHEN MOVING FROM WORKSTATION TO WORKSTATION	EFFICIENCY QUALITY/ FLEXIBILITY
4. MANUFACTURING OR PROCESSING PLANT	PROCESS CONTROL	· DELAYS DUE TO CHANGING DRYER SETTINGS · WASTE DUE TO LACK OF PROCESS CONTROL	EFFICIENCY FLEXIBILITY
5. QUALITY ASSURANCE	QUALITY CONTROL	· INABILITY TO MAINTAIN TIGHTER SPECS · VARIANCE IN VENEER SMOOTHNESS · > # REJECTED ORDERS · INABILITY TO PROPERLY ASSESS QUALITY OF LOGS FOR SLICING	QUALITY EFFICIENCY FLEXIBILITY DEPENDABILITY
6. PRODUCT DELIVERY/ TRANSPORTATION & INVENTORY	INVENTORY CONTROL	· WIP INVENTORY BOTTLENECKS · EXCESS FINISHED INVENTORY · MOISTURE CONTENT CONTROL OVERSEAS MARKET	EFFICIENCY QUALITY
7. OTHER			

STEP 5 - IDENTIFY WHICH AMTs WILL BEST HELP YOU TO COMPETE

This step is designed to help you identify and focus on AMTs that will best help your company to compete. It is intended to give you some AMT ideas for your company, and come up with a "long list" of potential AMT applications. This will be cut down to a "short list" in Step 6. **If you already have a good idea of the AMT applications that you want to evaluate, you may skim this step, or even skip it entirely.**

ACTION:
SELECT THE WORKSHEET FOR YOUR INDUSTRY IN APPENDIX A

AMT applications are provided in Appendix A for six industry groupings:

- electronics
- forestry products
- metal fabrication
- non-metal fabrication
- machinery
- food products.

Examine the worksheet for your industry and consider those AMTs that will address your company's needs. For an explanation of the various applications listed on the worksheets, you may wish to review the glossary of terms at the back of this guide. Even if you are not in one of these industries, you can still use the worksheet most applicable to your company.

The circles which appear in the table are relative values that indicate the likelihood that a particular AMT, listed at the left, will assist you in achieving the five goals for the indicators of competitiveness, listed across the columns. The circles in the table are shown in three shadings, representing:

⬭	(White)	This application will not substantially help meet the noted goal
⬬	(Grey)	This application can help meet the noted goal, either directly or as a by-product of meeting another goal
⬬	(Black)	This application will substantially help achieve the noted goal.

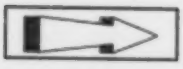
The worksheets in Appendix A are provided as a starting point for you to change while using this guide. They are not exhaustive. When completing them, add other AMT applications specific to your industry. You may also wish to change some values if, in your judgement, the application is not valued appropriately for your company at this time.

ACTION:
ENTER PRIORITY RANKINGS ON WORKSHEET

Enter your priorities, ranked from 1 to 5 as determined in Step 3, on the row entitled "Priority" on the worksheet for your industry.

ACTION:
LOOK FOR POTENTIAL AMT APPLICATIONS

Starting with your highest priority (1), go down the columns and see which AMTs could best help you achieve your company's goals. Then look at the other priority columns, and see if this AMT application makes sense for you to consider at this time.



ACTION:
CHECK THE AMT APPLICATIONS TO DETERMINE THE "LONG LIST"

Place a check mark in the right hand column for those AMT applications most likely to help achieve your company's goals. If your company has a particular need that has not been given a high value, check it anyway. Also, bring forward any ideas of your own that were not reflected in this worksheet. Your judgement is still the best indicator of your needs. This will provide the "long list" of AMT applications to consider in the next step.

Miller used the list of AMT applications for the Forestry products sector from Appendix A and copied in the priority of New Timber's goals established earlier. Miller scanned down the Quality column first, and found several AMT's with black circles. Miller looked across the rows of these several AMT's and thought about those that made most sense for New Timber. Miller then checked three AMT's: CNC, DNC and CAM. Miller's completed worksheet is shown in Case Example F.

CASE EXAMPLE F

LIST OF AMT APPLICATIONS
FORESTRY PRODUCTS
NEW TIMBER INC.

AMT APPLICATION	INDICATOR OF COMPETITIVENESS					
	EFFICIENCY	FLEXIBILITY	QUALITY	INNOVATION	DEPENDABILITY	✓
PRIORITY →	2	3	1	4	5	
PRODUCT/PROCESS DESIGN						
- Computer Aided Drafting	○	●	◎	○	○	
- Computer Aided Design (CAD)	○	●	◎	○	○	
- Computer Aided Process Planning (CAPP)	●	○	○	●	●	
- Computer Aided Engineering (CAE)	○	●	◎	●	●	
- Artificial Intelligence	○	◎	●	◎	◎	
PRODUCTION PROCESS						
- Programmable Controllers	○	◎	●	○	◎	
- Computer Numeric Control (CNC)	●	●	●	●	●	✓
- Direct Numeric Control (DNC)	●	●	●	●	●	✓
- Simple Robotics	◎	◎	◎	◎	◎	
- Complex Robotics	◎	◎	●	●	●	
- Computer Aided Manufacturing (CAM)	●	●	●	●	●	✓
- Bar Coded Data Collection	◎	○	○	○	◎	
- Computer Integrated Manufacturing (CIM)	●	●	●	◎	◎	
PROCESS CONTROL						
- Sensor-Based Systems	◎	○	◎	○	◎	
QUALITY ASSURANCE						
- Computer Aided Inspection (CAI)	◎	○	●	○	◎	
- Computer Aided Testing (CAT)	◎	○	●	○	◎	
PLANNING						
- Manuf. Resource Planning (MRP II)	◎	●	○	○	●	
- Just In Time (JIT)	◎	●	○	○	●	
INFORMATION TECHNOLOGIES						
- Electronic Data Interchange (EDI)	○	○	○	●	○	
- Laboratory Sample Control	○	○	●	○	○	
OTHER						

STEP 6 - IDENTIFY SPECIFIC AMT APPLICATIONS

This step uses the identified long list of AMT applications to determine which can solve your company's specific problems and whether adopting those applications is feasible.

There are several sources of information to access in further acquainting yourself with the technologies and applications. These sources include:

- relevant trade and technical journals
- present and potential customers
- trade associations, research associations and professional institutions
- universities and university industrial research institutes
- management consultants and consulting engineers
- technology exchange fairs, exhibitions, conferences
- AMT suppliers
- the AMT Research Centre
- your own staff.

When identifying specific AMT applications, consider the degree to which a specific AMT has been adopted by your competitors. Acquiring a widely available and widely adopted AMT is less risky to you, but will also yield less competitive advantage. On the other hand, being first to adopt relatively new AMT is inherently risky but could result in substantial and sustainable competitive advantage.

Many Canadian firms are far behind their international competitors in adopting AMT and are forced to make large investments in newer AMT to remain competitive. In such cases, the president or CEO is sometimes forced to accept a higher degree of risk by adopting newer AMT as a means of remaining internationally competitive.

Be sure to consider the fact that proprietary and custom AMT applications developed within your company to suit your specific needs offer you increased competitive advantage. Some widely available AMTs could offer very little competitive advantage, or could offer an advantage that is not sustainable, because your competitors can also acquire and easily install the same AMTs.

ACTION:
COMPLETE QUESTIONNAIRE FOR EACH AMT APPLICATION IDENTIFIED

Use Exhibit 5 as a starting point to answer questions about each problem or opportunity identified in Step 4 and the applicability of the AMT applications identified in Step 5. Some research may be necessary to answer the following questions with either a Yes, Qualified Yes, or a No:

1. Are you reasonably sure the application will solve the identified problems or realize opportunities? Have other manufacturers or processors resolved this problem?

2. Does the application help meet any of your company's priority goals? Is it aligned with your business plan?

3. Is the application available today and possible to implement in your company?

4. Is the manufacturing process sound? If not and if it requires major changes, the process should be re-examined and improved. Investments made in AMT without considering its effect on the entire manufacturing process is unlikely to provide long-term benefits.

5. Will the application help your company become substantially more competitive?

6. Can your company afford the application? If the cost is unreasonable it should probably be set aside at this point.

7. Is the application compatible with your existing technology? The full benefits of AMT are best achieved within an integrated environment. Incompatible technology creates additional complexities that many companies are not prepared to handle.

8. Can the application be integrated with your existing technology? Incremental investments will have considerably less negative effect on your company and staff than first time investments. Such "experiments" carry a greater degree of risk.

9. Do you anticipate that your staff will accept an AMT that will change the way specific jobs are performed?

10. Can you acquire the given AMT from a single or several reliable suppliers? Too many suppliers may result in an AMT application that cannot be integrated.

11. Do you recognize the risks associated with purchasing a particularly innovative AMT application?

Exhibit 5

DATE _____

STEP 6 -
IDENTIFY SPECIFIC AMT APPLICATIONS

SPECIFIC PROCESS _____

PROBLEM/OPPORTUNITY _____

AMT APPLICATION _____

QUESTION	YES ✓	QUALIFIED YES ✓	NO ✓
1. Are you reasonably sure the application will solve the identified problems or realize opportunities?			
2. Does the application help meet any of your company's priority goals?			
3. Is the application available today and possible to implement in your company?			
4. Is the manufacturing process sound?			
5. Will the application help your company become substantially more competitive?			
6. Can your company afford the application?			
7. Is the application compatible with your existing technology?			
8. Can the application be integrated with your existing technology?			
9. Do you anticipate that staff will accept an AMT that will change the way specific jobs are performed?			
10. Can you acquire the given AMT from a single or several reliable suppliers?			
11. Do you recognize the risks associated with purchasing a particularly innovative AMT application?			

ACTION:
CARRY FORWARD SHORT LIST OF AMTs FOR DETAILED EVALUATION

These responses should stimulate your thinking and help provide a clearer picture of the likely feasibility of the AMT applications under consideration. While all of these potential applications could be evaluated in detail, the objective of this phase is identify those AMT applications that your company is most likely to introduce and implement successfully.

By eliminating AMT applications with one or more No answers, and selecting only those where all or most answers are Yes or a Qualified Yes, you will maximize your likelihood of successfully investing in AMT. However, questions which you answered with a Qualified Yes may require further investigation.

The applications that survive this test make up the short list of AMTs to be evaluated in detail in Phase II.

Robin Miller isolated several AMT applications for consideration based on the analysis in Step 5, conducted some preliminary research and completed Exhibit 5 for each potential AMT. Miller's answers revealed that only two of the three AMT applications identified met New Timber's specific needs: Computer Numerically Controlled (CNC) Machinery and Computer Aided Manufacturing (CAM). Miller eliminated Direct Numeric Control (DNC) on the advice of a company that invested in the technology but found that it did not adequately address needs that were similar to those of New Timber. In addition, Miller did not wish to consider DNC further because of its high initial investment and maintenance costs.

Computer Numerically Controlled Machinery (CNC)

Miller is aware that applying basic CNC technology to the slicing operation can cut production costs by reducing waste and improving the quality of sliced veneer, especially higher priced veneers that are sliced thinner. With a CNC slicer, operators can rely on the computer to automatically reset the slicing blades, rather than having to judge the slicing widths themselves.

A CNC machine can also monitor the relative temperatures and humidity of both the slicing blade and the wood being sliced. By controlling an integrated cooling system, the CNC machine would ensure a precision slice, resulting in a smoother finish and a flatter veneer surface, thereby increasing the veneer's quality.

Finally, a CNC machine can monitor and correct variations in slicing thickness, thereby ensuring a greater quality consistency in the sliced veneer and reducing the amount of waste.

Computer Aided Manufacturing (CAM)

Miller believes a simple CAM application within the mill could better regulate the flow of the manufacturing process, ensure greater product quality and increase throughput. However, the manufacturing process is quite complex, and the CAM application would be more beneficial in terms of cost reduction and quality improvement and in introducing greater manufacturing flexibility in the production process.

When a log enters debarking, all operations must be completed in a timed sequence to maintain quality and yield. Fast change-overs, involving changing slicer settings and dryer temperature zone, represent costly delays. Veneer is often damaged when workers manipulate it from one workstation to another using small trolley carts or when they load veneer onto the slicing bed with use of a crane. In addition, work-in-process bottlenecks often arise in the manufacturing process.

By installing a CAM-controlled conveyor system that requires minimal human intervention, damage to veneer can be reduced. By monitoring the moisture content and density of the wood to be sliced, the CAM system can regulate the line to accommodate the wood's specifications and improve the veneer's quality. In addition, a console operator can schedule the shift's production by pre-programming the characteristics of logs to be sliced. In this way, CAM can automatically recalibrate the slicers to accommodate the needs of a given order. Finally, an optical scanner can assist handlers in identifying knots and other imperfections in logs and ensure an economical 100 percent quality control check on veneer smoothness, thickness and surface consistency.

PHASE II: EVALUATE AMT ALTERNATIVES

Choosing among investment alternatives is often difficult. That task is even harder when the choice concerns rapidly changing technology. Traditionally, investments in manufacturing and processing equipment were justified by analyzing and comparing costs to the resulting dollar benefits.

That approach is not suitable for AMT investments because many benefits lie in other areas. These include "strategic" benefits that are difficult to quantify despite being essential to competitiveness. Such benefits include shorter lead times, more consistent product quality, a more timely delivery schedule and an improved ability to react to changing demands. In addition, a traditional cost/benefit analysis often fails to consider a company's overall direction. Investing in AMT that is economically justifiable and in line with a company's direction will maximize its probability of success.

An added difficulty in choosing among AMT investments is that the costs and benefits of new technology are not always easy to isolate, because new manufacturing or processing technologies can comprise:

- stand-alone equipment
- linked technology, or
- integrated technology.

Robots and computer numerically controlled (CNC) machine tools are often in stand-alone equipment, though they can be integrated into other systems. It is relatively straightforward to apply traditional cost/benefit analyses to these applications.

It becomes difficult to apply traditional analyses in cases of linked technology. This refers to stand-alone systems that are linked together, such as in group technology (GT), or when computer aided design (CAD) is linked with computer aided process planning (CAPP). In these situations, an intermediate level of integration is achieved that exhibits a synergy among the previously independent systems.

Fully integrated technology refers to situations where the design, planning, materials handling, manufacturing or processing and support systems are all fully linked through computer control. Justifying investments at this level of technology requires an approach that includes the strategic benefits, though tactical and economic ones will accrue as well.

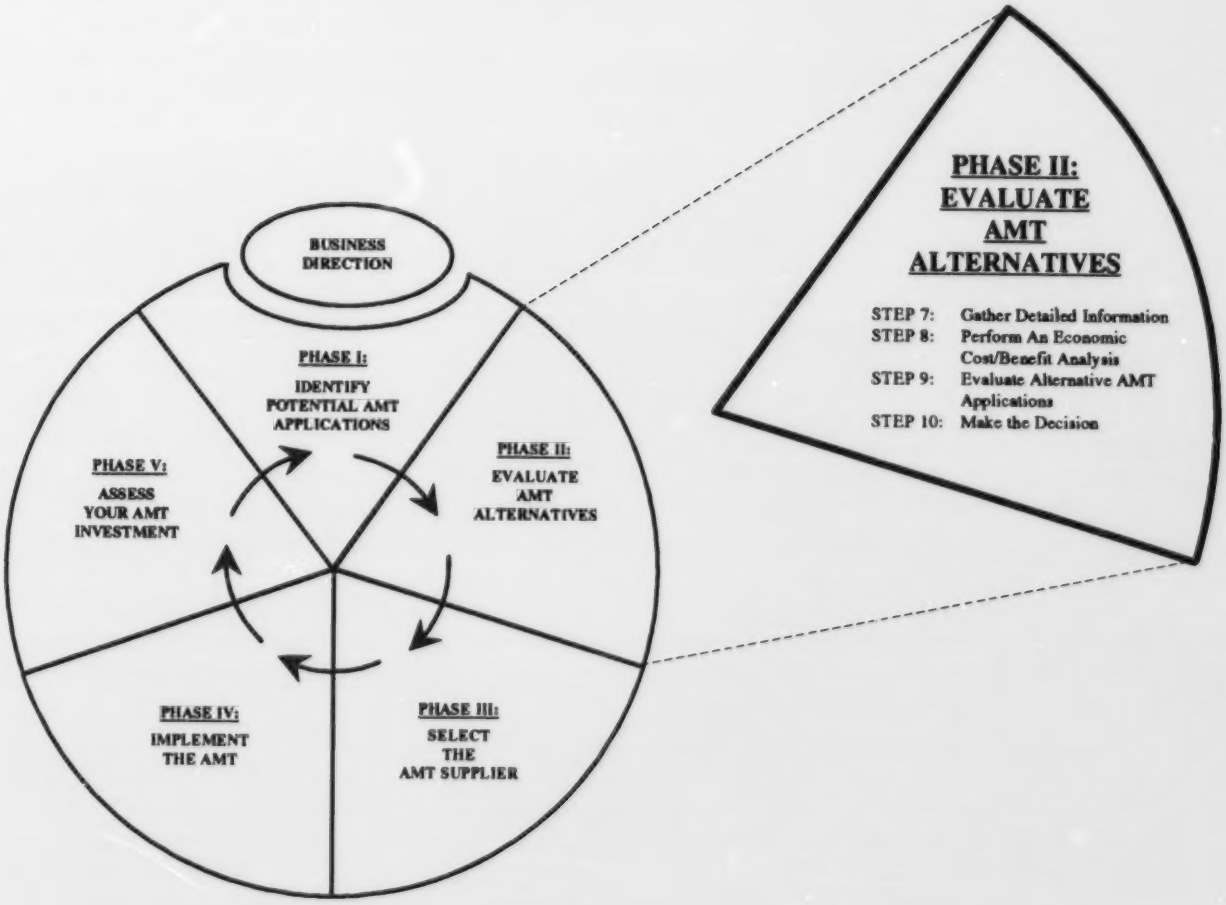
The method presented in this phase of the guide is designed to provide a comprehensive, easy to follow evaluation process that incorporates the wider issues of an application's strategic "value" to your company in addition to performing cost/benefit analyses.

To complete this phase, you must have developed the short list of potential applications from Phase I to be evaluated in detail. The phase will guide you through gathering information on costs and benefits and then applying a cost/benefit analysis for each alternative. The results of this analysis will be incorporated into an evaluation model that also includes competitive, problem, technology, risk and other factors. You must weight each criteria in the evaluation to reflect the importance your company places on those criteria when making its capital investment decisions.

Exhibit 6 depicts this phase in diagram form.

Exhibit 6

PHASE II
EVALUATE AMT ALTERNATIVES



STEP 7 - GATHER DETAILED INFORMATION

It is important to gather detailed information about each potential AMT application to be evaluated. (You may wish to delegate this task to others.) The information is necessary to identify costs and benefits and to assess risk, determine potential support for your company goals and the AMT's effect on your employees.

This evaluation will address six areas (which you should keep in mind when gathering information):

- economic cost/benefit
- competitive advantage
- problem resolution and opportunities
- technology understanding and compatibility
- risks
- other.

ACTION:
GATHER DETAILED INFORMATION ABOUT EACH AMT ALTERNATIVE

Phase I identified potential information sources including AMT suppliers, customer references, trade shows, trade associations, consultants and your own customers and suppliers. Exhibit 7 provides three lists of questions to use in obtaining information from those sources. The list is not exhaustive; it is intended as a starting point as to the areas in which to probe.

Ideally, you should talk to other manufacturers or processors who have already implemented the technology; these may be your competitors or companies in other industries. Be sure to talk with consultants experienced with the technology.

While it is relatively easy to ascertain a new project's capital costs, it can be much more difficult to gain an accurate idea of the cost of installing it. Therefore, be sure to address issues such as:

- How many technical staff were required to assist with the implementation and for how long were they involved?

DATE _____

STEP 7 -
GATHER DETAILED INFORMATION

INFORMATION SOURCE	SAMPLE QUESTIONS
Current AMT Users (Your Competition or in Other Industries)	How did you arrive at your decision to invest in AMT? Which AMT vendors do you recommend or not recommend? Why? What was the final cost of your AMT installation? Was it what you expected? How long has the AMT been installed? Have you received the benefits/returns anticipated? What has been the impact on existing staff? Did you pre-train your staff? How did you train your existing staff? Did you hire additional staff with knowledge of the specific AMT? What changes were required to your physical plant prior to introducing AMT? Did you phase in the AMT implementation? How? Did you encounter any unanticipated problems? How could they have been avoided? Would you recommend your AMT environment to others? Were you eligible for government funding and/or grants? Are you planning further AMT investments? May I tour your facility?

DATE _____

STEP 7 -
GATHER DETAILED INFORMATION

INFORMATION SOURCE	SAMPLE QUESTIONS
Trade Associations/ Publications/ Government/ National Research Council	Which source lists are available for AMT vendors in my industry? Are you aware of other organizations in my industry that have invested in AMT and whom I could contact? Which of these installations have been successful? Which have failed? Why? Are you aware of other organizations in my industry contemplating an AMT investment? Who are the experienced consulting firms who can assist me? What literature is available to explain the AMT options to me? Are there sources of industry support available from government?

DATE _____

STEP 7 -
GATHER DETAILED INFORMATION

INFORMATION SOURCE	SAMPLE QUESTIONS
AMT Suppliers/ Trade Shows	Where have you installed the AMT? How many installations? Could I have a list of references and contact names? What is the price of the basic AMT? What are the prices of separate AMT options that I may require? What benefits have your other clients realized by installing the technology? What has been the impact on staff within other client organizations? How will this new technology integrate with my existing technology? Do you service the AMT you sell? What are the anticipated maintenance costs? Is there a newer version of this AMT available? When will it be available? What problems can I anticipate? How can I avoid them? What changes to my physical plant will be required to prepare for the AMT? What will be the impact on my staff? To what extent can I preserve my existing investment in AMT? What are the technical specifications of the proposed AMT? Can I tour one of your existing installations?

- What were the training costs and how disruptive was implementation on the production schedule?
- What is the need and cost for ongoing support?
- Have you achieved a successful and cost beneficial implementation?

Consultants can help you by objectively relating other companies' experiences. They can help you avoid pitfalls encountered by others and understand the benefits that were actually realized.

When gathering information, don't be discouraged by accounts of problems and failure. There are always successes and failures, with numerous reasons for either. Instead, be sure to determine the:

- factors that underlie the success or failure for these companies
- real costs of implementing the application
- benefits that will accrue, both tangible and intangible
- potential suppliers, particularly those with a good reputation for ongoing support
- lessons you can learn from other installations of this technology that can be applied to your business.

To make sound decisions you must know the facts, both negative and positive. Too often, presidents or CEOs attempt to select an option arbitrarily or out of personal preference. Being impatient for action or desiring a quick solution has led many companies to adopt approaches or technologies that were not always the best options available.

Robin Miller wanted to learn as much as possible about the two AMT applications that were isolated as possible investment choices.

As part of the information gathering process, Miller attended a trade show sponsored by producers of a wide range of products including CAD, CAM, CIM and CAE, among others. Miller invited one of the plant engineers to attend the show as well. Over the two days they met many AMT suppliers and discussed New Timber's manufacturing problems. By the time the trade show ended, Miller had gained a wealth of valuable information to facilitate the AMT investment decision.

Miller also contacted several industry associations to discuss where to find additional information that would be worthwhile in evaluating AMT applications. Upon the advice of one association, Miller contacted other manufacturers in the forest products industry which had successfully invested in and implemented AMT. Miller learned from their experiences and began considering the costs and benefits of New Timber's own AMT investment.

STEP 8 - PERFORM AN ECONOMIC COST/BENEFIT ANALYSIS

A cost/benefit analysis enables you to assess applications in terms of their relative benefits and costs. For the purposes of such an analysis, a benefit would be a cost saving, cost avoidance, generation of new revenue or an intangible, such as a consistent product quality. A cost would be the amount of a resource required to produce a product. This cost/benefit analysis will probably be required when approaching your banker for financing.

The cost/benefit analysis is one of six criteria which will be used in the Final Evaluation Table in Step 9. (You may wish to delegate this task to others).

Estimating Benefits

Estimate the quantitative benefits (in dollar terms) and qualitative benefits associated with each alternative over the AMT project's life. Some quantitative benefits of AMT include:

- increased capacity and yields due to better control of the production process
- increased flexibility and shorter set-up times
- repeatability over short and long production runs
- improved labour productivity
- reduced scrap, wastes or pollutants
- increased reliability or reduced maintenance
- reduced work-in-progress and finished goods inventory
- reduced inspection and product-testing.

Some qualitative benefits of AMT include:

- increased product competitiveness
- improved overall efficiency and effectiveness
- better customer relations
- quicker response to customer needs
- ability to enter new markets
- more timely information leading to better decisions
- improved employee morale due to elimination of dirty, dull or dangerous jobs.

Estimating Costs

Estimate the costs associated with each alternative application over the AMT project's life. These will either be one-time costs, associated with implementing the technology, or ongoing costs, associated with maintaining and operating it.

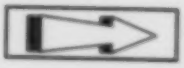
Calculating the Cost/Benefit

Calculate the cost/benefit for each alternative. The summary worksheet indicates cumulative costs and benefits, net benefit, payback period and other information, depending on the investment's size and magnitude.

The method used to evaluate cost/benefit may vary according to the AMT's scope and magnitude. For example, calculating net present value (NPV) may be used instead of payback period where magnitude and timing of cash flows are important.

To properly document and conduct the cost/benefit analysis, use the worksheets from Appendices B, C and D in performing the following actions:

ACTION:
ESTIMATE THE TOTAL BENEFITS FOR EACH AMT APPLICATION, USING THE *BENEFITS DETAIL WORKSHEETS* IN APPENDIX B



ACTION:
SELECT THE QUALITATIVE BENEFITS THAT APPLY TO EACH ALTERNATIVE, USING THE *BENEFITS CHECKLIST* IN APPENDIX B (AND ADD OTHERS AS APPROPRIATE)

ACTION:
ESTIMATE THE TOTAL COSTS (BOTH ONE-TIME AND ONGOING) FOR EACH AMT APPLICATION, USING THE *COST DETAIL WORKSHEETS* IN APPENDIX C

ACTION:
SUMMARIZE THE BENEFIT AND COST INFORMATION AND CALCULATE THE COST/BENEFIT FOR EACH ALTERNATIVE ON THE *COST/BENEFIT SUMMARY WORKSHEET* IN APPENDIX D

Robin Miller considered the CAM application first and completed the benefit and cost worksheets presented in Appendices B and C as shown in Case Example G:

CASE EXAMPLE G
BENEFIT AND COST CALCULATIONS

AMT ECONOMIC ANALYSIS
BENEFITS DETAIL WORKSHEET
NEW TIMBER INC. - CAM

QUANTITATIVE BENEFITS ($000's)

		Yr. 1 1990	Yr. 2 1991	Yr. 3 1992	Yr. 4 1993	Yr. 5 1994	Total
Labour Savings							
	Increased Revenue*						
1.	(3rd Shift)	0	$7,044	$8,731	$10,657	$8,993	$35,425
2.	_____	____	____	____	____	____	____
Direct Savings							
	Proceeds from Sale						
3.	of Old Equipment	0	183	0	0	0	183
	Energy						
4.	Savings	0	25	25	25	25	100
5.	_____	____	____	____	____	____	____
Indirect Savings							
	Decreased						
6.	Turnover	0	15	15	15	15	60
	Lower						
7.	Absenteeism	0	5	5	5	5	20
TOTAL BENEFITS		0	$7,272	$8,776	$10,702	$9,038	$35,788

*Robin Miller maintains the current workforce but, as a result of AMT, can add a third shift. By keeping labour constant but increasing output, sales revenues increase and labour costs are avoided.

AMT ECONOMIC ANALYSIS
COST DETAIL WORKSHEET
NEW TIMBER INC. - CAM

ESTIMATED ANNUAL COSTS ($000's)
A. ONE-TIME COSTS:

		Yr. 1 1990	Yr. 2 1991	Yr. 3 1992	Yr. 4 1993	Yr. 5 1994	Total
Purchases and Capital Costs							
1.	CAM	$2,000	0	0	0	0	$2,000
2.	_____	____	____	____	____	____	____
Sub-total, Purchases and Capital Costs		$2,000	0	0	0	0	$2,000

CASE EXAMPLE G (CONT'D)
BENEFIT AND COST CALCULATIONS

AMT ECONOMIC ANALYSIS
COST DETAIL WORKSHEET
NEW TIMBER INC. - CAM

A. ONE-TIME COSTS ($000's)

		Yr. 1 1990	Yr. 2 1991	Yr. 3 1992	Yr. 4 1993	Yr. 5 1994	Total
Professional Services, Labour Costs, Other Support							
1.	Consulting	$ 25	0	0	0	0	$ 25
2.	Training	$ 50	0	0	0	0	$ 50
3.	_____	___	___	___	___	___	___
TOTAL ONE-TIME COSTS		$ 75	0	0	0	0	$ 75

AMT ECONOMIC ANALYSIS
COST DETAIL WORKSHEET
NEW TIMBER INC. - CAM

B. ONGOING COSTS ($000's)

		Yr. 1 1990	Yr. 2 1991	Yr. 3 1992	Yr. 4 1993	Yr. 5 1994	Total
Maintenance							
	CAM						
1.	Maintenance	$ 5	$ 5	$ 5	$ 5	$ 5	$ 25
2.	_____	___	___	___	___	___	___
Leases							
3.	_____	___	___	___	___	___	___
Operations							
	Cost of						
4.	Production	0	5,500	6,930	8,400	7,700	28,530
	Operating						
5.	Costs	0	493	611	746	630	2,480
6.	_____	___	___	___	___	___	___
TOTAL ONGOING COSTS		$ 5	$5,998	$7,546	$9,151	$8,335	$31,005

Miller's summary cost/benefit information from the tables in the worksheet in Appendix D is shown in Case Example H.

CASE EXAMPLE H
COST/BENEFIT SUMMARY

AMT ECONOMIC ANALYSIS
COST/BENEFIT SUMMARY WORKSHEET
NEW TIMBER INC. - CAM

QUANTITATIVE BENEFITS ($000's)

	Yr. 1 1990	Yr. 2 1991	Yr. 3 1992	Yr. 4 1993	Yr. 5 1994	Total
1. Total Benefits	0	$7,272	$8,776	$10,702	$9,038	$35,788
2. Total Cumulative Benefits	0	7,272	16,048	26,750	35,788	35,788
COSTS						
3. One-Time Costs	2,075	0	0	0	0	2,075
4. Ongoing Costs	5	5,998	7,566	9,151	8,335	31,055
5. Total Costs	2,080	5,998	7,566	9,151	8,335	33,130
6. Total Cumulative Costs	2,080	8,078	15,644	24,795	33,130	33,130
7. Benefits - Costs	(2,080)	1,274	1,210	1,551	703	2,658
8. Cumulative Benefits - Costs	(2,080)	(806)	404	1,955	2,658	2,658
9. Benefits ÷ Costs	0	1.21	1.16	1.17	1.08	1.08
10. Cumulative Benefits ÷ Costs	0	0.90	1.03	1.08	1.08	1.08

11. PAYBACK OCCURS IN YEAR (line 10 > 1.0)	1992
12. At a required rate of return or hurdle rate of:	10%
13. Net Present Value (Total P.V. of Benefits - Total P.V. of Costs)	$2,658,000
14. I.R.R. (%) (Internal Rate of Return)	46.5%

Given its current financial and technological situation, New Timber cannot support additional human resources to increase plant throughput and revenues. However, after installing of CAM system, Miller expects that the two current shifts will each require 40 percent fewer mill personnel.

Therefore, Miller plans to add a third shift and, by keeping the same workforce level, anticipates a substantial increase in plant throughput and revenues. Miller knows that, based on current foreign demands for high quality veneer products, the sales force can sell the additional veneer with little difficulty.

In calculating benefits, Miller included planned increases in revenue, projected energy savings and proceeds from the sale of the current equipment. Miller also anticipates that employee turnover and absenteeism will decrease as a result of an improved working environment and an enhanced quality of worklife. However, to be conservative, Miller only stated benefits commencing in the year after the installation of the AMT technology (1991) and onward, though Miller knows some benefits will be realized in 1990.

Offsetting the benefits, Miller included costs associated with installing the CAM system (such as new equipment, increased operating and production costs for the extra shift, training and maintenance). The cost/benefit summary demonstrated a favourable investment in CAM system with a projected payback in the third year, 1992.

When Miller went through the same exercise to evaluate the CNC choice Miller's calculated Internal Rate of Return (IRR) was only 12 percent, well below the rate for the CAM application. Both the CNC and CAM provide IRR's greater than New Timber's required rate of return, or "hurdle rate". Therefore, both are worthwhile investments to make. For New Timber CAM is the AMT with greatest economic value to the company at this time.

STEP 9 - EVALUATE ALTERNATIVE AMT APPLICATIONS

This step describes how to evaluate prospective AMT applications against each other to determine their feasibility and the order in which they should be implemented. This step also allows the evaluation of one AMT application against the status quo, if you so choose, by evaluating the status quo as the first alternative.

This evaluation cannot be based on financial considerations alone. An application that takes four years to provide a return on its initial investment may be a better solution than one that provides a faster return. The cost/benefit analysis you completed in Step 8 considers only identifiable economic costs and benefits. It cannot determine an application's true worth to your company because it does not include strategic and intangible benefits or risks.

A broader concept which incorporates these and other factors, such as competitive advantage, is value. Value, the basis for determining whether investing in AMT is worthwhile, is assessed by adding business performance factors to tangible benefits. Similarly, the definition of cost should be expanded to include different ways AMT investments require the input of company resources.

By examining these additional areas, you can assess the true impact of AMT on your organization. In this step, consider the six criteria that provide a more balanced view of the investment alternatives within your company:

- economic cost/benefit
- competitive advantage
- problem resolution and opportunities
- technology understanding and compatibility
- risks
- other.

To evaluate the applications, begin by assigning weights to each of the six criteria to establish their relative importance to your company. The assigned weights will depend on your company's priorities. (This is done on a company-wide level; the weights are the same for each application.)

ACTION:
ASSIGN WEIGHTS TO CRITERIA IN FINAL EVALUATION TABLE

All of the criteria must be weighed against the others. Assign a weight to each criterion that is between 0.05 to 0.90 (the total of all weights must equal 1.00).

For example, the most important criterion might be given a weight of 0.40, and the least important given 0.10. These weights are very important to objectively and effectively evaluate your alternatives. This process should be done once only, without considering the individual applications to be evaluated. Then, enter the weights on the Final Evaluation Table shown in Exhibit 8. To assist you in assigning weights and considering the criteria, it may be helpful to consider these descriptions:

Economic Cost/Benefit

This is the criterion described in Step 8.

Competitive Advantage

Competitive advantage focuses on the degree to which the AMT application supports your company's strategic goals, as outlined in your business plan. This provides a means of valuing innovative applications that enhance your competitive ability. An AMT will provide a competitive advantage if it helps differentiate your products from those of your competitors in ways that are important to your target market. It will also provide a competitive advantage if it helps establish and maintain a low cost position relative to your competitors.

Problem Resolution and Opportunities

Problem resolution and opportunities also utilizes the five indicators of competitiveness from Phase I, but considers the problem areas that hinder your company from achieving its goals in the short-term. Your need for quick fixes is important here.

Technology Understanding and Compatibility

Technology understanding and compatibility considers the existing technology within your company and the implications of implementing new and incompatible technology. It also looks at the AMT technology to determine its level of acceptance and support within your company and how well your staff is equipped to handle its introduction.

DATE _____

STEP 9 -
FINAL EVALUATION TABLE

CRITERIA	WEIGHT	APPLICATION 1:		APPLICATION 2:		APPLICATION 3:	
		RAW SCORE (1-5)	WEIGHTED SCORE	RAW SCORE (1-5)	WEIGHTED SCORE	RAW SCORE (1-5)	WEIGHTED SCORE
ECONOMIC COST/BENEFIT							
COMPETITIVE ADVANTAGE							
PROBLEM RESOLUTION AND OPPORTUNITIES							
TECHNOLOGY UNDERSTANDING AND COMPATIBILITY							
RISKS							
OTHER							
TOTAL	1.00						

Exhibit 8

Risks

Consider the risks and uncertainties you face in investing in AMT. These risks can be managed or reduced. Risk areas include:

- Business risk: Is your company financially stable? Is AMT viewed as being the saviour of your operation? Adopting AMT may seriously disrupt your company's organization and operations, or the financial burden might be too great at this time. This type of risk can be reduced by making small, phased investments that are introduced slowly.

- Organizational risk: How willing are you to make organizational changes as a result of AMT? Will you be able to recognize and accommodate the procedural changes required by the technology?

  Organizational change is often necessary to realize the full benefits of AMT. Organizational risks are minimal in companies where structural changes in response to environmental factors have been frequent and the organizational culture is dynamic. Given that you are willing to make changes, this risk can be managed. While studying the technology used by other companies will help, if this risk is a concern be sure to seek assistance from consultants experienced in industrial engineering and organizational change management.

- Personnel risk: Does your company have sufficient skills to carry out an AMT implementation? Will your workforce be enthusiastic or resistant to this kind of change? Are there any union considerations?

  Using external skills will reduce some of this risk, but it is most important that you consult and train your staff and unions to manage this risk.

- External risk: Is there a risk of damaging the environment with the new technology? Are there any regulatory or political considerations? Does your company face more or fewer risks with this AMT application?

Understanding the experiences of others will help you assess any potential damage, and prospective AMT suppliers can tell you of methods to minimize this. Be sure to consult any lawyers, consultants and other experts that you require.

Other

The Final Evaluation Table includes one more criterion, entitled "Other". This category allows you to include the value to be gained from the intangible benefits listed in Appendix B that were collected during the information gathering stage. Or, you may use this section to define other criteria unique to your company. Some of these additional criteria could include timing, the availability of skilled resources, cash flow and affordability, or other elements of particular importance to your company.

Robin Miller assigned weights to the various decision criteria based on historic experience. For New Timber, the importance of economic cost/benefit and competitive advantage are identical. The weights assigned to all the criteria total 1.00. Miller's weights are shown in Case Example I.

CASE EXAMPLE I

FINAL EVALUATION TABLE - PART 1
NEW TIMBER INC.

CRITERIA	WEIGHT	APPLICATION 1: CAM		APPLICATION 2: CNC	
		RAW SCORE (1-5)	WEIGHTED SCORE	RAW SCORE (1-5)	WEIGHTED SCORE
ECONOMIC COST/BENEFIT	.30				
COMPETITIVE ADVANTAGE	.30				
PROBLEM RESOLUTION AND OPPORTUNITIES	.20				
TECHNOLOGY UNDERSTANDING AND COMPATIBILITY	.10				
RISKS	.10				
OTHER	—				
TOTAL	1.00				

ACTION:
ASSIGN RAW SCORES TO AMT APPLICATIONS

Shift from considering overall company-wide decision criteria to focusing on individual AMT applications. To assign a raw score for each criteria to each AMT application, use the Evaluation Scale Definitions table, Exhibit 9. If you wish, you may customize the evaluation scale definitions in the table to match with your company's needs.

For example, in considering an AMT application, you have already calculated the IRR, NPV and payback period in Step 8. You would assign a raw score of 5 to economic cost/benefit if the particular AMT yielded an NPV substantially greater than zero and a payback realizable in two years or less. If the AMT application will contribute to some long-term competitive advantage, a raw score of 3 would be appropriate for competitive advantage. If the AMT application will only contribute marginally to fixing your current problems, a raw score of 2 would be appropriate.

Think about each of the five or six criteria for the first application. Use the Commentary Sheet in Exhibit 10 to record your thoughts on the specific AMT application you are considering.

If you wish to consider the status quo as one of your alternatives, you can evaluate this option in a similar manner to other AMT alternative applications you may be considering. In the case of the economic cost/benefit criterion, the raw score for the status quo option will be 2, as indicated in Exhibit 9. The economic cost/benefit of new AMT applications will either lie below a score of 2 (i.e. a negative return and an NPV of less than 0) or above a score of 2 (i.e. a positive return and an NPV of greater than 0). Across the other criteria, the status quo option could merit any of the raw scores 1 to 5, depending on your company's current situation.

Now conduct the same scoring process across all criteria for every AMT application being considered. Note that Exhibit 8 only includes space for three alternatives. If you are considering more alternatives, use additional copies of the table.

It should be emphasized that this is not a rigorous, scientific calculation, and it does require a high degree of personal judgement.

STEP 9 -
EVALUATION SCALE DEFINITIONS

CRITERIA	RAW SCORES				
	1	2	3	4	5
ECONOMIC COST/BENEFIT	Has a negative return, NPV < 0; the application must be justified by other criteria	Status Quo Marginal or no return and NPV = 0	Provides an adequate return, NPV is > 0 and payback in 5 years or less		Provides an excellent return, NPV > > 0, and payback in 2 years or less
COMPETITIVE ADVANTAGE	New or current technology provides no competitive advantage		New or current technology provides some long term competitive advantage		New or current technology provides long term sustainable competitive advantage
PROBLEM RESOLUTION AND OPPORTUNITIES	New or current technology does not contribute materially to solving current problems		New or current technology fixes current problems in an adequate fashion		New or current technology fixes problems and will ensure competitiveness for years
TECHNOLOGY UNDERSTANDING AND COMPATIBILITY	New or current technology is unproven or will have to be custom developed		Other firms are using new or current technology and people on your staff are comfortable with it		New or current technology is easy to understand
RISKS: - Business Risk - Organizational Risk - Personnel Risk - External Risk	All risks are high with new or current technology		Acceptable level of risk. New or current technology is mature and risks are understood and manageable		All risks are low with new or current technology
OTHER:					

Exhibit 9

DATE _____

STEP 9 -

EVALUATION COMMENTARY SHEET

AMT APPLICATION: _____

EVALUATION COMMENTS
ECONOMIC COST/BENEFIT:
COMPETITIVE ADVANTAGE:
PROBLEM RESOLUTION AND OPPORTUNITIES:
TECHNOLOGY UNDERSTANDING AND COMPATIBILITY:
RISKS:
OTHER:

ACTION:
CALCULATE AND ENTER WEIGHTED SCORES

On the Final Evaluation Table in Exhibit 8, multiply each "Raw Score" by the appropriate "Weight" that you assigned to each criteria to calculate the "Weighted Score". Enter these for each AMT application under consideration in the appropriate square on the Final Evaluation Table.

ACTION:
CALCULATE AND ENTER TOTAL WEIGHTED SCORE

To complete the Final Evaluation Table in Exhibit 8, add up the "Weighted Score" columns and enter the total amount in the "Total" row for each application. The total must be between 0.10 and 5.00.

Compare the total scores for each AMT application. Note that small differences in total scores between alternatives (less that 0.5 difference) are not significant. In some cases, you may not feel comfortable choosing an AMT application despite the fact that it has the higher score which indicates it is the most appropriate choice. This evaluation method identifies the most valuable AMT alternatives for your company by the highest weighted score total. Choosing the alternatives to implement is discussed in the next step.

Robin Miller calculated and entered the total weighted scores and completed the Final Evaluation Table as shown in Case Example J.

CASE EXAMPLE J

FINAL EVALUATION TABLE - PART 2
NEW TIMBER INC.

CRITERIA	WEIGHT	APPLICATION 1: CAM		APPLICATION 2: CNC	
		RAW SCORE (1-5)	WEIGHTED SCORE	RAW SCORE (1-5)	WEIGHTED SCORE
ECONOMIC COST/BENEFIT	.30	5	1.5	3	.9
COMPETITIVE ADVANTAGE	.30	4	1.2	3	.9
PROBLEM RESOLUTION AND OPPORTUNITIES	.20	5	1.0	3	.6
TECHNOLOGY UNDERSTANDING AND COMPATIBILITY	.10	2	.2	4	.4
RISKS	.10	2	.2	4	.4
OTHER	—	—	—	—	—
TOTAL	1.00		4.1		3.3

STEP 10 - MAKE THE DECISION

Generally, the higher the weighted score total an AMT application is given, the more appropriate it is for your company. Through use of the Final Evaluation Table, you have translated your various thoughts, impressions and judgements together with objective and quantifiable facts into comparative scores for each alternative. In choosing an AMT using this method, you are basing your decision on a comprehensive approach to the problem. As the president or CEO, the foundation upon which you base your decision and the decision itself are ultimately up to you.

Depending upon your company's situation, you may not necessarily choose the application that has the highest rating. It may make more sense to implement the second or third alternative first, and leaving the "best" one for later. There is no substitute for your experienced judgement in making this decision. However, in making that choice, it may be advisable to talk with additional parties, such as your company's owner, accountant, consultant, bank manager or lawyer, to confirm your thinking and to organize funding.

It is also possible that you will have to justify the proposed acquisition by preparing a business case using the data you gathered in this guide. Bankers are primarily interested in positive returns, so a project justified on other grounds will necessarily be questioned more closely. However, once you confirm the availability of funds, the final decision to acquire is yours to make. You have done the research and considered everything to minimize the risks. Though you can never have a guarantee of success, you have completed a step-by-step process that objectively identified and evaluated the applications most likely to benefit your company.

After further deliberation and lengthy discussions with New Timber's banker, Robin Miller's choice was clear. By using the process outlined in this guide, and performing an extensive analysis of the various AMT alternatives, Miller felt comfortable preparing an investment proposal for the board of directors. Miller recommended purchasing and installing a CAM system which will assist New Timber in realizing its short- and long-term business goals and will reposition the company as a premier worldwide producer of high quality specialty veneers.

PHASE III: SELECT THE AMT SUPPLIER

Several methods and books are available to assist you in preparing requirements specifications, developing selection criteria, evaluating potential supplier alternatives and, finally, selecting a supplier. This phase does not provide detailed "how to" instructions on this process. Rather, it includes some of the key success factors which underlie other successful implementations. It also provides a standard checklist of areas that should be covered. The steps in this phase are illustrated in Exhibit 11.

KEY SUCCESS FACTORS

A number of key success factors have been identified that are common to most successful AMT projects. They all directly or indirectly affect the planning process which is the necessary prerequisite for selecting new AMT. These success factors include:

Use a proven selection method

- Follow a proven method to ensure that you adopt a formal, step-by-step approach to defining your requirements and selecting the right supplier and system to meet them.

- Use an available method. Your method can be obtained from a number of sources. For example, it can be purchased through certain technical book stores or obtained through accounting, management consulting or engineering consulting firms. The structured selection process this guide provides is an overview of one such selection process method.

Use professional and expert advice

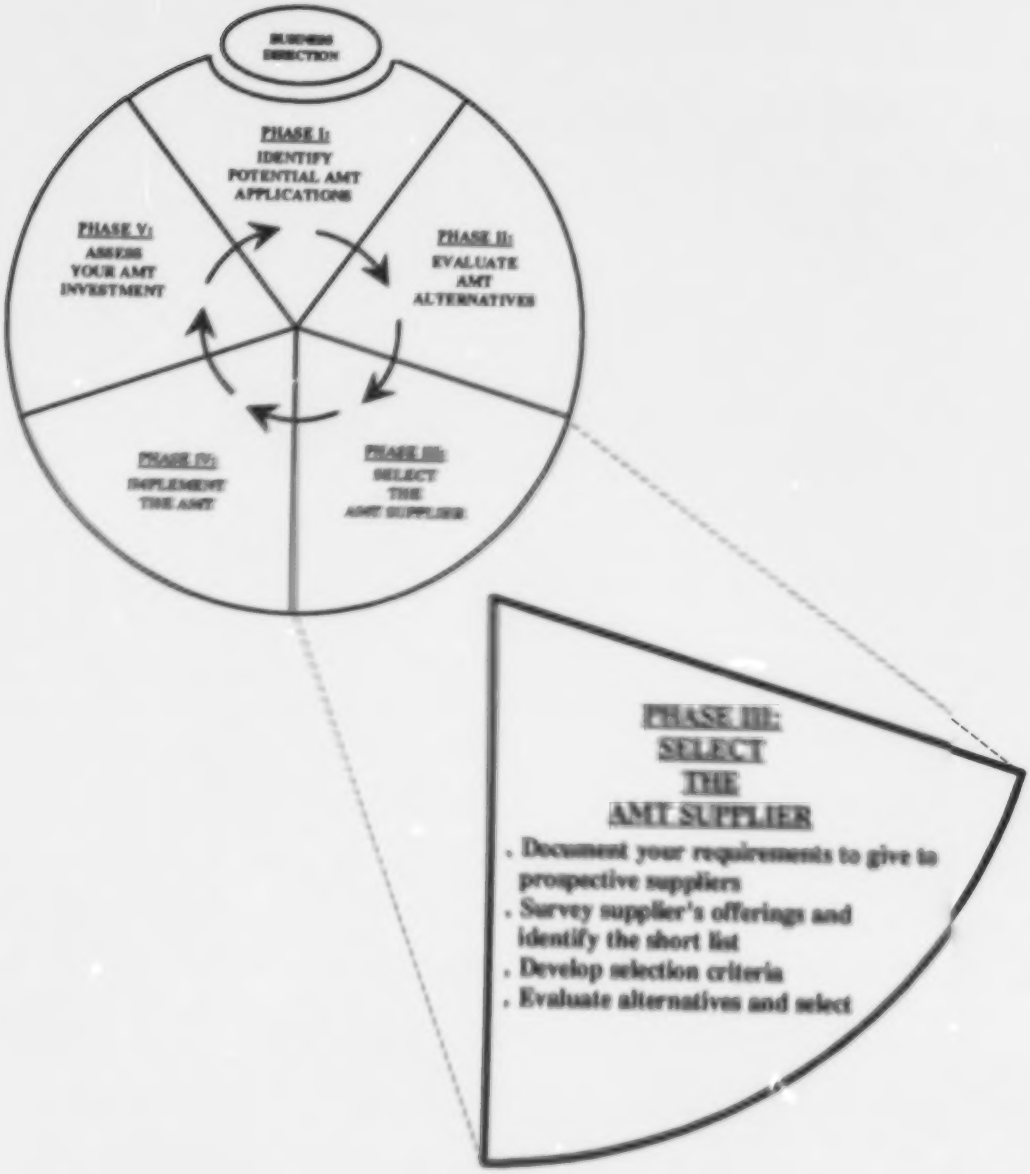
- Consider "buying" some expertise to weave through the myriad of suppliers and product offerings.

- Seek professional advice early in the project. Be sure your advisors have a good understanding of your industry, gain a good knowledge of your business and are in a position to provide objective advice.

- Tap into your potential AMT supplier's experience to obtain complete solutions. Don't just buy equipment.

Exhibit 11

PHASE III
SELECT THE AMT SUPPLIER



Clearly define objectives and performance goals

- Write down exactly what your company hopes to achieve with the new technology. Define your objectives and performance goals as clearly as possible so you can evaluate the project and quantify the value of the benefits.

- View each technology investment as a step towards the longer-term goal. Show how each project achieves its own objective, and also how it fits into your long-range business plan.

Encourage and ensure user participation in the process

- Involve users in the process to help facilitate a smooth implementation. Identify individual roles and responsibilities.

- Seek user input throughout the project. Encourage the users to take ownership of the project. Experience demonstrates that systems work best if their users are consulted, involved and allowed to influence the end result. This gives users the opportunity to "buy into" the new system.

Ensure that the right champion sponsors the project

- The champion should be you, as the president, CEO or senior manager with authority to make decisions and act on them without justifying every step with the owner.

- The champion need not necessarily have a background in AMT, but must know the business intimately. You may rely on users to provide the technical expertise.

- The champion should also be involved with eventually implementing the system.

SUGGESTED STEPS FOR THE SELECTION PROCESS

Document your requirements for prospective suppliers

- Reconfirm and document your company's requirements and constraints
- Document the application to be automated
- Determine the performance requirements
- List the reports/output you need to monitor and control
- Detail the interfaces and links to other systems.

Survey suppliers' offerings and identify the short list

- Survey suppliers' offerings
- Compare the offerings to your stated requirements
- Develop primary evaluation criteria
- Identify the short list (2-4 vendors).

Develop selection criteria

- Review present system
- Review functional requirements
- Review technical requirements
- Review other requirements
- Define functional and technical criteria
- Finalize selection criteria and assign priorities and weights
- Establish those criteria which are mandatory and those which are desirable.

Evaluate alternatives and select

- Obtain quotations or send out a Request for Proposal
- Receive suppliers' proposals/quotations
- Evaluate features of the proposals
- Compare cost/benefit analyses
- Perform full evaluation of alternatives according to pre-established selection criteria
- Make preliminary selection
- Review selection with owner
- Negotiate contract terms with the supplier
- Seek owner final approval and signature on contract
- Notify losing suppliers of your decision.

PHASE IV: IMPLEMENT THE AMT

Again, there are many methods and books available to assist you in implementing your new AMT. In a format similar to Phase III, this phase includes some key success factors which underlie other successful AMT implementations. It also provides a standard checklist of areas to be covered. The steps in this phase are illustrated in Exhibit 12.

KEY SUCCESS FACTORS

A number of key success factors have been identified that are common to the implementation of most successful AMT projects. Most are the result of hard-earned experience and include the following.

Keep the champion involved

Ensure that the champion of the project remains committed to the project and involved to the appropriate degree.

Plan the change process

Some people's initial response to change is negative. Resistance comes in three forms: barriers to understanding, barriers to acceptance and barriers to action.

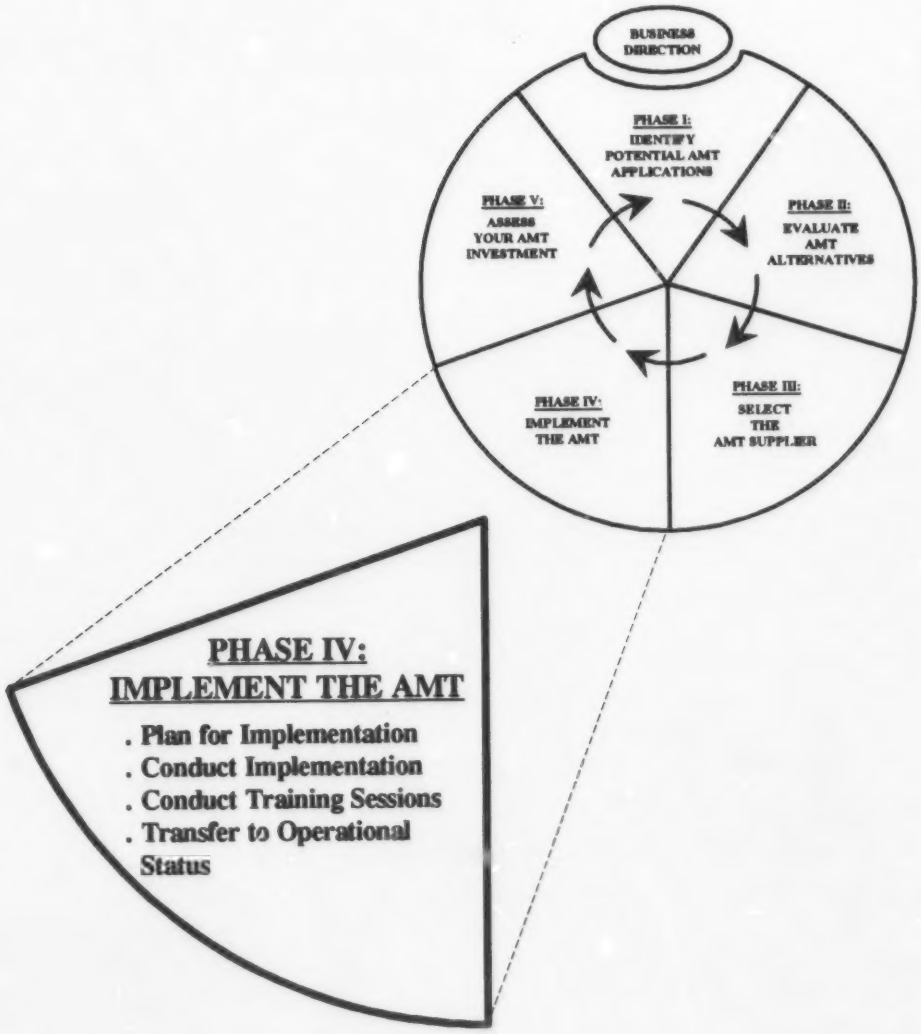
- Barriers to understanding can stem from a lack of knowledge of the new technology, a misunderstanding of its consequences or inconsistent messages about it. This can be overcome through good two-way communications, an awareness program and through education.

- Barriers to acceptance arise from the perception that the technology is unnecessary, a poor organizational climate, perceived loss of job security, loss of power and a history of poorly managed change in the company.

- Barriers to action stem from inadequate skills, resources, time, rewards or support from top management.

Exhibit 12

PHASE IV
IMPLEMENT THE AMT



Do not underestimate the people side of AMT projects. The process must be made clear to everyone involved. People require adequate training, time to "play" with the new equipment and time for user group meetings. You must budget and plan for the change process.

Involve users in the process

- Involve a steering committee to ensure that you consider the project's company-wide effect and that sufficient resources are made available to the project. A steering committee could consist of a representative cross-section of those employees and managers that you expect the AMT will effect. Their views, opinions, concerns and suggestions will, no doubt, help facilitate a smooth AMT implementation.

- Involve staff in the change process to build trust, motivation, and commitment. This is vital to the project's success.

- Make decisions that affect staff early, and communicate them quickly, regardless of whether the news is good or bad.

- Take preventative action early on issues such as health and safety and industrial relations to help reduce opportunities for conflicts to grow.

Consider organizational changes that may be required

- Consider the efficiencies that can be gained through reviewing procedures and job designs when you are implementing the AMT. You may wish to avoid most companies' tendency to automate existing procedures and work arrangements.

- Plan and budget carefully for organizational changes if the new technology is to achieve its stated objectives. The more radical the change brought by introducing the new AMT, the greater the structural changes required to support it.

Conduct training

- Recognize that implementing AMT can cause changes in staff duties. Training is an opportunity to motivate and involve the staff in the new technology.

- Make opportunities for your staff to use the new technology before it is implemented to help reduce any fear, uncertainty or doubt they may have about it.

- Ensure that your technical staff understand that their careers are linked to the company's success in achieving its long-term goals. Try to ensure that these key staff have a career commitment to your company. Provide them with business and technical training, and give them time to learn about the company's products and services.

Use a knowledgeable supplier and/or expert assistance

- Establish trust and confidence between your AMT supplier and your company to help lay the foundation for a long-term relationship. Hold project team meetings at your location and your supplier's to get to know each other better.

- Take advantage of the existence of a supplier and/or outside consultant who understands the system's capabilities and your company's requirements.

SUGGESTED STEPS FOR THE IMPLEMENTATION PROCESS

This is a structured process for implementing AMT. Although it is quite general, it provides a path to be followed to ensure that no major steps are omitted.

Plan for implementation

- Develop an implementation plan

- Review the plan with the group that will maintain the system after it is implemented

- Prepare a "live test" plan

- Establish resource requirements

- Prepare the user site premises

- Plan for conversion including additional temporary resource requirements

- Finalize the user guides.

Conduct implementation

- Establish an appropriate change or cut-over time
- Be prepared for a certain level of chaos for a while after implementation
- Consider running a parallel system (the new with the old) for a short period, or provide for a comprehensive test of the new system after which you will then cut over to it "cold turkey"
- Conduct one-time activities to set-up the new system
- Conduct extensive tests prior to implementation.

Conduct training sessions

- Discuss decisions, progress and other issues with your staff
- Hold information sessions prior to implementing the AMT to dispel any rumours and respond to employee concerns
- Issue the user guides
- Train system users
- Provide a help line for staff to use when they encounter trouble with the system
- Follow up after implementing the system with refresher or advanced training.

Transfer to operational status

- Establish a period of time in which the system will still be "in implementation"
- Monitor production from the new system
- Have a sign-off by the main user groups that the system is now operational
- Hand over to maintenance.

PHASE V: ASSESS YOUR AMT INVESTMENT

Once your AMT project has been implemented and operating for some time, you will want to be sure that it, in fact, provides the benefits you expected.

In this phase, a post-implementation review, you will assess the AMT's effect on your company. To conduct this review, be sure to collect data and information over the AMT's life. Tracking your AMT's benefits and costs over time, while monitoring your position compared to your competitors and any changes in your business strategy, allows you to compare the actual effect of your AMT to the results you expected to achieve.

Assessing an AMT investment is [illegible] over time. Each review should examine a particular aspect of your company's operation. The results should provide an indication of quantitative and qualitative gains in performance.

For example, one AMT may produce immediate quantifiable benefits in the form of increased efficiency. Another AMT may result in improved product quality, lower employee turnover, enhanced quality of work life or some other intangible benefits which take longer to realize and are more difficult to measure. In either situation, the AMT's value to your company is determined by comparing the benefits you expected to those you actually realized over the useful life of your AMT.

These reviews take time and effort, and should be seen as a continuation of your investment. Through these reviews, you will learn more about your AMT, which will benefit you in making your next AMT investment.

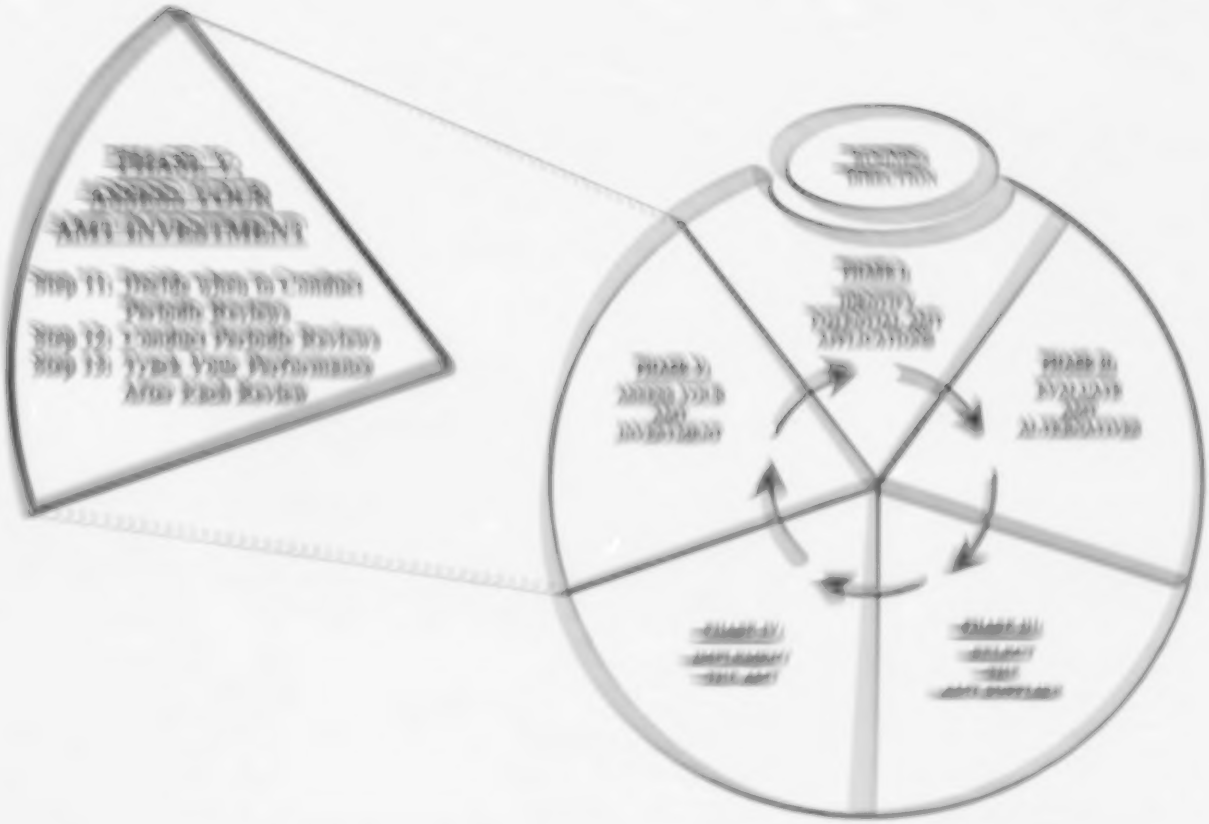
This phase evaluates actual to planned performance using the six criteria used in Phase II to evaluate AMT alternatives. These decision criteria were:

- economic cost/benefit
- competitive advantage
- problem resolution
- technology understanding and compatibility
- risks
- other.

The three steps involved in assessing [illegible]

Exhibit 13

PHASE V
ASSESS YOUR AMT INVESTMENT



STEP 11 - DETERMINE WHEN TO CONDUCT PERIODIC REVIEWS

You must decide when to conduct periodic reviews of your AMT investment because your AMT and your situation are unique. You should also expect to achieve certain objectives faster than others.

ACTION:
DETERMINE WHEN TO CONDUCT THE REVIEWS

Use your judgement in establishing the times that you will assess your AMT project. Some factors you should consider when setting these review times include the:

- AMT's lifetime,
- speed to which you desire the benefits and cost accruing,
- availability of data to measure the criteria that you will measure,
- time and effort required to conduct the assessment.

For example, a large scale six-axis CNC machine might last 20 years. The benefits of this machine may start small, grow steadily over five years, and then level off. It may be appropriate to review this AMT investment after 2, 3, 7 and 10 years. On the other hand, a new state of the art machine that uses a new raw material may provide your company with a huge competitive advantage for the next six months, but will be obsolete in two years. Appropriate times to review this AMT investment might be after 6, 12, 18 and 24 months.

ACTION:
SET UP THE PERFORMANCE TRACKING TABLE AND GRAPH

Once you decide when to conduct the reviews, mark the scheduled review dates on the Performance Tracking Table, shown in Exhibit 14. Copy the date of your original assessment, and the weight, raw scores and weighted scores for the AMT application from Step 9 on the Final Evaluation Table in Exhibit 8. Then, add the dates you established for the first, second, third, fourth and fifth reviews across the top of the table.

Next, set up the Performance Tracking Graph, shown in Exhibit 15. Then, use the same dates as the Performance Tracking Table and present it in graph form. Copy the date of your original assessment. Then, plot the points of your current weighted score with the date of your original assessment. Finally, add the review dates across the bottom of the graph.

STEPS 11, 12 & 13
PERFORMANCE TRACKING TABLE

AMT APPLICATION: _____

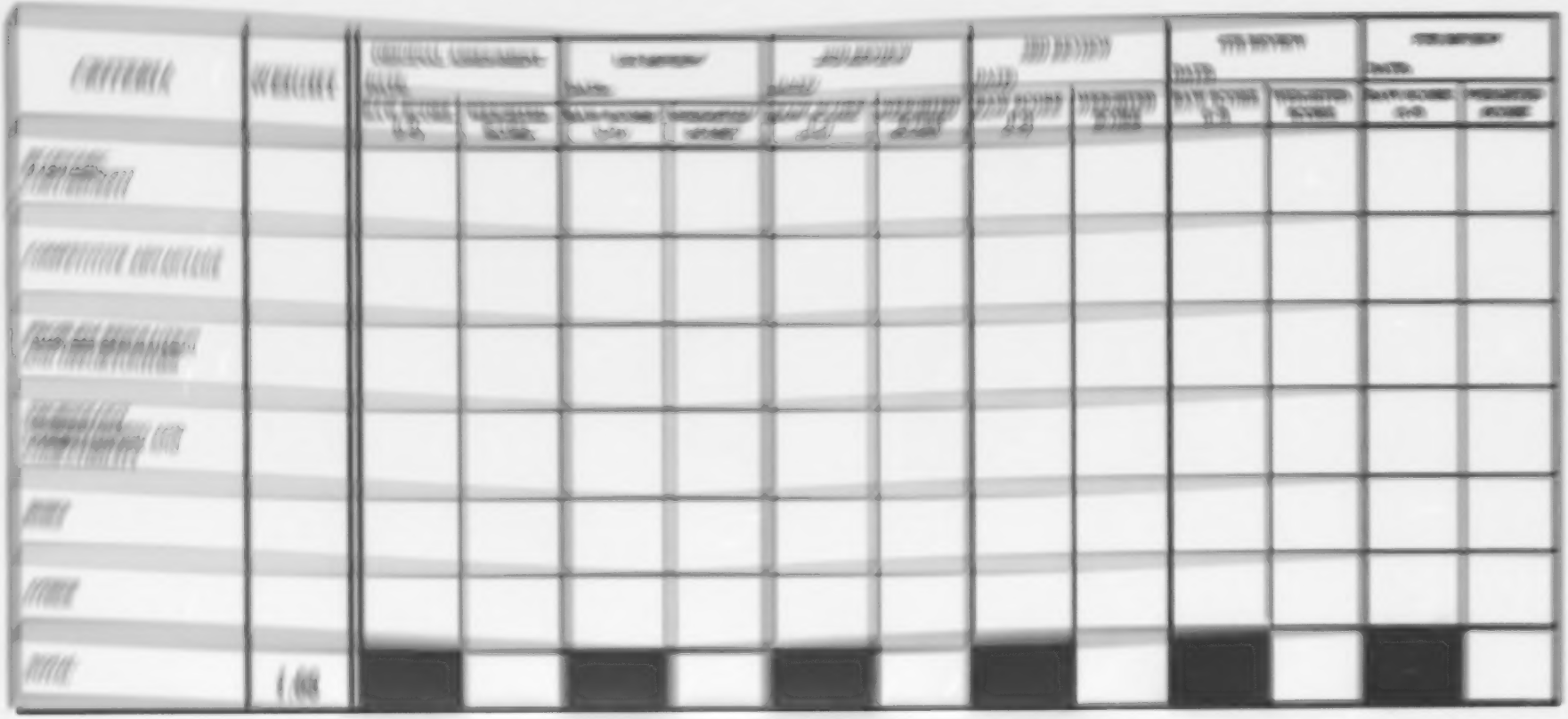


Exhibit 14

STEPS 11, 12 & 13
PERFORMANCE TRACKING GRAPH

AMT APPLICATION: _____

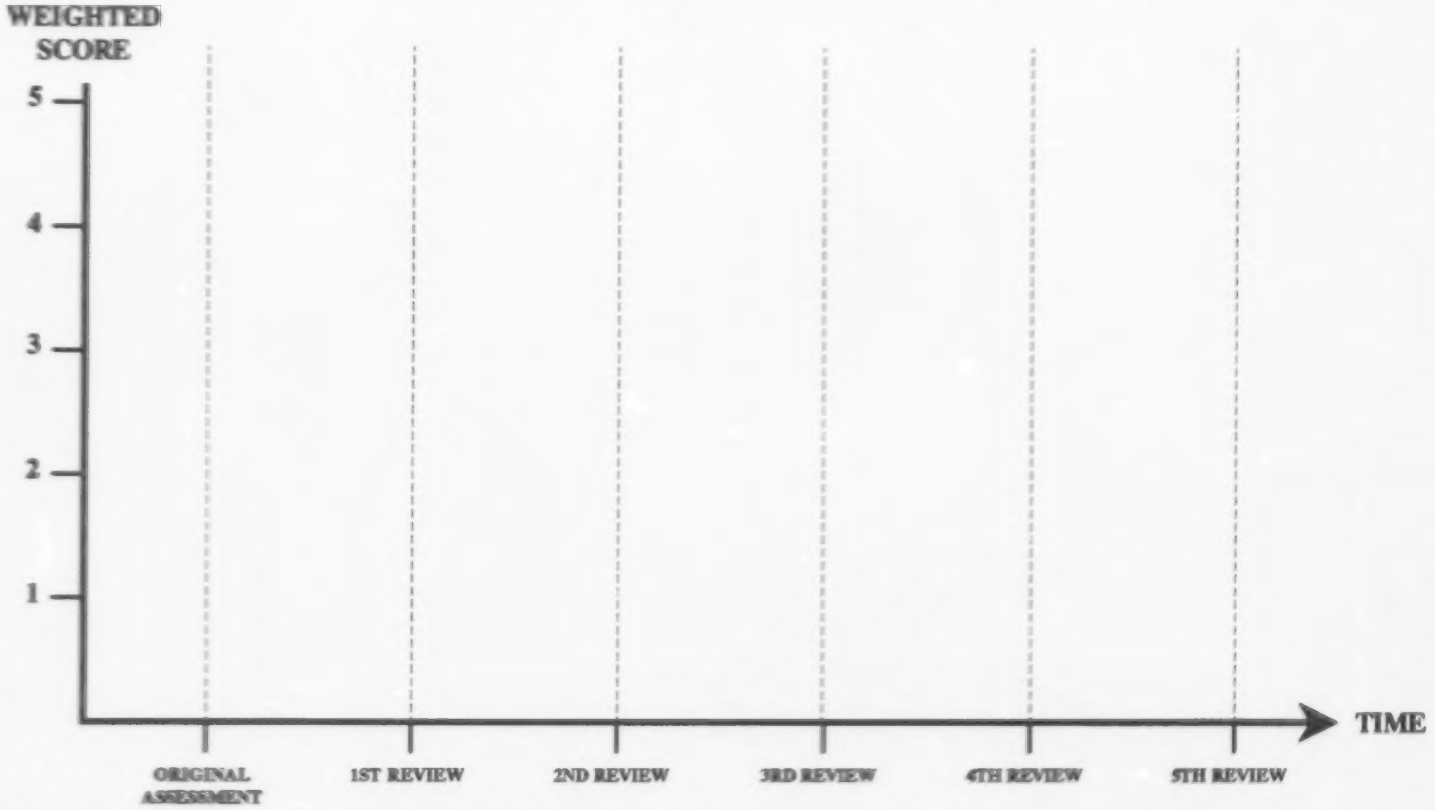
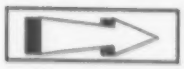


Exhibit 15

STEP 12 - CONDUCT PERIODIC REVIEWS

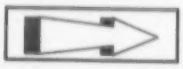
Each periodic review should assess all the evaluation criteria you considered when you made your AMT investment (even though some criteria will be easier to evaluate at certain times than others). During each review, decide whether the AMT has improved your company's performance as measured by those criteria. You must also determine whether your company is making progress in realizing your short- and long-term goals.



ACTION:
RECALCULATE ECONOMIC COST/BENEFIT AND ASSIGN RAW SCORE

Using Appendices B, C and D, recalculate economic cost/benefit, net present value (NPV), internal rate of return (IRR) and the payback period. These calculations allow you to assess the degree to which your AMT investment is providing the quantifiable benefits. By comparing these recalculations to the original estimates that you made in Phase II, Step 8, you can determine any differences between your AMT's actual and anticipated performance.

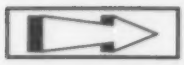
Assign a raw score for this criterion using Exhibit 9, and enter it on the Performance Tracking Table in Exhibit 14.



ACTION:
REASSESS COMPETITIVE ADVANTAGE AND ASSIGN RAW SCORE

Survey your market and reassess your competitive position. Measuring your position against your competitors requires you to monitor your competitors' activities and understand the dynamics of your industry. At this stage, you should determine whether your AMT has provided you with the competitive advantage you expected when you made your investment decision.

Assign a raw score for this criterion using Exhibit 9, and enter it on the Performance Tracking Table in Exhibit 14.



ACTION:
REASSESS PROBLEM RESOLUTION AND OPPORTUNITIES AND ASSIGN RAW SCORE

Determine whether the AMT investment addressed the problems you originally identified and if your company realized the opportunities it expected. To assess this, look at both your company's internal operational performance and its external competitiveness.

Assign a raw score for this criterion using Exhibit 9, and enter it on the Performance Tracking Table in Exhibit 14.

ACTION:
REASSESS TECHNOLOGY UNDERSTANDING AND COMPATIBILITY AND ASSIGN RAW SCORE

Determine whether your staff found the AMT easy or difficult to understand and use. Determine whether it was compatible with existing technology, and whether your company achieved synergy in its operations by implementing the AMT.

To answer these questions, you must focus on your company's operations. Interview your employees to get feedback from those with hands-on experience and a working knowledge of the AMT. These people are best positioned to tell you how the AMT affects their work and helps operations.

Assign a raw score for this criterion using Exhibit 9, and enter it on the Performance Tracking Table in Exhibit 14.

ACTION:
REASSESS RISKS AND ASSIGN RAW SCORE

Determine whether your original risk assessment was accurate and how well your company has coped with the risks it experienced. This involves assessing both internal and external risks. Be sure to examine all the risk factors you originally considered and determine how they affected your company.

Assign a raw score for this criterion using Exhibit 9, and enter it on the Performance Tracking Table in Exhibit 14.

ACTION:
REASSESS OTHER CONSIDERATIONS AND ASSIGN RAW SCORE

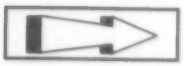
Determine whether any of the other concerns you anticipated when you made your AMT investment were justified. Determine whether the AMT investment has helped or hindered your company's ability to realize its strategic business goals.

This assessment also involves both an internal and external focus. Be sure to assess whether the AMT helped achieve your company's long-term goals of competitiveness and profitability.

Assign a raw score for this criterion using Exhibit 9, and enter it on the Performance Tracking Table in Exhibit 14.

ACTION:
CALCULATE AND ENTER WEIGHTED SCORES

On the Performance Tracking Table, multiply each "Raw Score" by the appropriate "Weight" assigned to each criterion, to calculate the "Weighted Score".



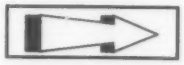
ACTION
CALCULATE AND ENTER TOTAL WEIGHTED SCORE

To complete the Performance Tracking Table, add up the "Weighted Score" column for this review and enter the total in the "Total" box at the bottom.

This assessment should provide some indication about where your AMT investment currently stands. A longer-term view of the trend of your AMT investment is described in the next step.

STEP 13 - TRACK YOUR PERFORMANCE AFTER EACH REVIEW

Steps 11 and 12 described how to schedule and complete periodic reviews. To assess your progress over time, track your performance results across all criteria from each review. This is best illustrated by using a graph. You may prefer to use a spreadsheet or a graphics software package for this step.



ACTION:
PLOT WEIGHTED SCORES FOR EACH CRITERION AND CONNECT THE DOTS ON THE GRAPH

Place a dot (•) on the Performance Tracking Graph, shown in Exhibit 15, in the appropriate intersection of WEIGHTED SCORE and TIME.

Draw a line to connect that dot to the previous dot for the same criterion. Repeat this process for each of the six criteria and for the total score. To more easily see your performance against any one criterion, it is best to use different colours, line types (for example, dotted lines) or line thicknesses for each criterion.

Graph your performance for each criterion and the total score during each periodic review. The graphs will demonstrate actual trends or directions which you can use to determine whether your company is on track in achieving its objectives. The graph may also help you identify the need for any "mid-course corrections" to improve your performance.

It is also a good idea to graph some of your key operational indicators on a regular basis. Some of these indicators should improve over time, while others should decline. For example, increases are desirable in indicators such as the number of pieces produced per employee or the company's market share. Decreases are preferable for hours of labour input per piece or the time to design new products. You should determine several indicators that are of key importance to your business.

In the case of New Timber, Robin Miller completed Step 11. Miller did not wish to start assessing the company's investment before the expected benefits of CAM had time to materialize. That would only be the case following one full year of plant operation with CAM in place. Therefore, Miller decided it was appropriate to assess the company's AMT investment annually, beginning at the end of 1991.

At the end of 1991, Step 12 was completed. Miller used Appendices B, C, and D to revisit the original calculations and discovered that the original estimate of one-time costs associated with CAM were too low. The installation costs involved in refitting the existing facility were substantially higher than anticipated because it was necessary to enlarge several doorways, remove walls and reinforce the plant floor to support the conveyor system. In total, the actual one-time costs were $600,000 higher than estimated.

In addition, turnover among staff increased immediately after CAM was installed in the plant. Miller suspects that the employees who left were either unwilling or unprepared to cope with changes to their jobs as a result of CAM. Because of that, one-time training costs for new employees were also higher than Miller expected, totalling close to $100,000. Miller expects the original benefit and cost estimates will hold in future years.

With these higher costs in mind, Miller recalculated the payback period, NPV and IRR:

Payback Occurs in Year:	1993
At hurdle rate of:	10%
Net Present Value:	$1,928,000
IRR:	27%

With these actual figures known, Miller referred to Exhibit 9 and adjusted the Economic Cost/Benefit raw score down to 3, reflecting the lower NPV and ROI and the longer payback period.

For Competitive Advantage, Miller realized that New Timber's investment in CAM has indeed helped the company recapture some of the market share it lost by being able to produce the highest quality veneer at a reasonable cost. The high end niche which Miller believed was the company's major market has been reaffirmed, a result of increased product quality, lower cost of production per unit sold, and increased manufacturing flexibility. Miller reassessed the competitive advantage and assigned a raw score of 5 which reflected the fact that CAM provided New Timber with a higher degree of competitive advantage sooner than expected.

Miller considered many problems and identified several opportunities before making the AMT investment. In talking with shop floor employees, Miller realized there were problems with the new technology and there were difficulties adapting to the demands of a new operating environment. As a result, some workers continued performing their tasks in the old way, relying on old, comfortable manual operations instead of CAM technology. Miller realized that until all employees adapt to their new operating environment CAM will not fully address New Timber's manufacturing problems. Miller reassessed the Problem Resolution and Opportunities criteria and assigned a raw score of 2, reflecting the fact that CAM has not yet addressed many of the identified problems.

Miller considered the level of Technology Understanding and Compatibility experienced by employees since CAM was introduced. There was a high turnover among experienced employees and some resistance to adopting CAM to its fullest potential exists. Therefore, Miller was forced to reduce the raw score to 1.

Finally, Miller reconsidered Risks. In retrospect, Miller felt the risks associated with the CAM investment were higher than originally anticipated, especially for Organizational and Personnel Risk. As a result, Miller decreased the raw score to 1.

Miller entered the new raw scores and calculated the weighted scores and total on the Performance Tracking Table as shown in Case Example K:

CASE EXAMPLE K

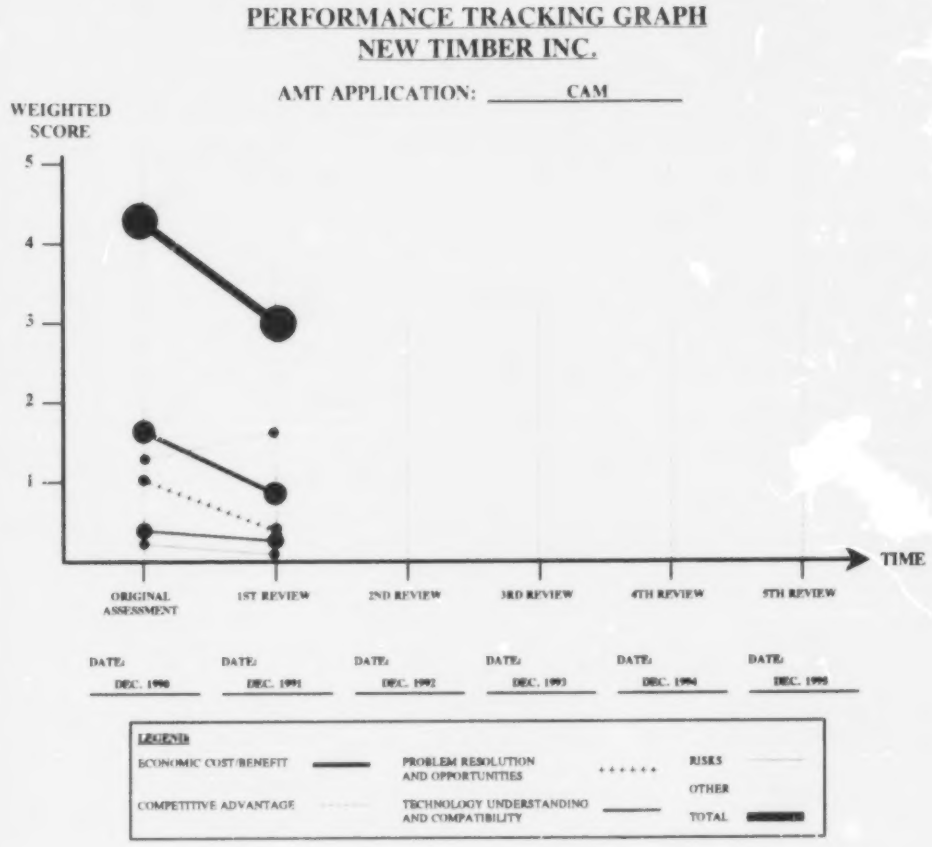
PERFORMANCE TRACKING TABLE
NEW TIMBER INC.

AMT APPLICATION: CAM

CRITERIA	WEIGHT	ORIGINAL ASSESSMENT DATE: DEC. 1990		1ST REVIEW DATE: DEC. 1991		2ND REVIEW DATE: DEC. 1992		3RD REVIEW DATE: DEC. 1993		4TH REVIEW DATE: DEC. 1994		5TH REVIEW DATE: DEC. 1995	
		RAW SCORE 0-5	WEIGHTED SCORE	RAW SCORE 0-5	WEIGHTED SCORE	RAW SCORE 0-5	WEIGHTED SCORE	RAW SCORE 0-5	WEIGHTED SCORE	RAW SCORE 0-5	WEIGHTED SCORE	RAW SCORE 0-5	WEIGHTED SCORE
ECONOMIC COST/BENEFIT	.30	5	1.5	3	.9								
COMPETITIVE ADVANTAGE	.30	4	1.2	5	1.5								
PROBLEM RESOLUTION AND OPPORTUNITIES	.20	5	1.0	2	.4								
TECHNOLOGY UNDERSTANDING AND COMPATIBILITY	.10	2	.2	1	.1								
RISKS	.10	2	.2	1	.1								
OTHER	——	——	——	——	——								
TOTAL	1.00		4.1		3.0								

After completing the Performance Tracking Table, Miller now plotted the dots for the five individual weighted scores and the total score, and drew lines to connect the new dots to those indicating the original assessment. Miller can now visualize New Timber's progress in realizing the promised benefits of CAM. The Performance Tracking Graph is shown in Case Example L:

CASE EXAMPLE L



Miller was in some ways disappointed with New Timber's progress in realizing the expected benefits of CAM but was not disheartened. The company's competitive position in its market was much stronger than it was before, and most of the staff were well along the learning curve for the new CAM technology. Robin Miller took steps to ensure that New Timber would be closer to achieving its original objectives by the time of the next review.

The process of investing in AMT is a continual cycle. By completing the steps described in Phase V, we have come full circle from identifying potential AMT applications and how they might help your company become more competitive, to making the investment decision, selecting an AMT supplier and implementing the technology, to conducting periodic reviews and assessing your AMT investment, you have followed a reliable method.

Though the cycle is complete, you should continually consider how AMT can help improve your competitive position. Begin again at Phase I to consider the next potential AMT applications. Do not allow your competitors to duplicate your strategy for success and continually strive to out-manoeuvre them through innovation and AMT.

Investing in AMT is a continuous and dynamic process. New and existing AMTs will be available to offer creative solutions to your problems or to help you realize new opportunities.

GLOSSARY OF AMT TERMS

Artificial Intelligence (AI)

A computer's ability to simulate certain human actions or skills, such as problem—solving. decision-making, perception and learning. Expert systems and pattern recognition are two specific examples of AI.

Automated Palletizer

This complex machine packages finished products automatically, stacks the boxes in an interlocking fashion on the pallet, shrink-wraps the pallet, and prints and attaches a bar-coded label, all with little or no manual intervention.

Bar Coded Data Collection

This is the process of labelling of certain items or products with bar codes. These products can be labelled directly once they are manufactured. Data, such as production date, weight, size and origin, can be immediately kept on each item. Once labelled, the item can be easily tracked as it is moved. This method has wide application in inventory control and is also used in the food industry, where samples of products are labelled before going to the laboratory for testing.

Computer Aided Design (CAD)

This is the use of computer workstations to design, simulate, test and generate graphical displays and models of new designs without actually having to produce a physical model. CAD automates the tasks of designers, draughtsmen and engineers. It assists in product design by providing timely, complete information (materials, weights, costs, performance criteria, etc.) about proposed designs. With Computer Aided Engineering (CAE), the computer can optimize the design and verify its conformity to industry standards well before the product ever goes into production.

Computer Aided Drafting (CAD)

CAD uses computers and appropriate output devices, such as graphic displays, laser printers and plotters, to generate standard engineering or other design specifications. CAD allows different orientations and perspectives of the design to be drafted quickly and also facilitates rapid modifications.

Computer Aided Engineering (CAE)

Together with Computer Aided Design (CAD), CAE takes electronic designs and optimizes them, verifies their conformity with industry standards, simulates the product's actual usage and tests it. CAE can help to minimize the components a product requires and, therefore, the cost to produce it.

Computer Aided Inspection (CAI)

CAI allows computers to be used to inspect products during production or when they are finished. Linked to sensors, scanners or video cameras, the computer inspects products and determines whether they conform to specifications. This is particularly useful in difficult to see or hazardous environments.

Computer Aided Process Planning (CAPP)

CAPP allows computers to help design and modify manufacturing process lines. The computer simulates, models, optimizes and streamlines new designs. Bottlenecks or potential weak points can be identified during simulation and corrected before construction or modifications begin.

Computer Aided Testing (CAT)

With CAT, computers can conduct either destructive or non-destructive tests on products to see if they conform to specifications. The tests can be carried out efficiently at the same time that the computer stores the test results. This data can be used to assess the quality of individual units or the characteristics of a batch. CAT is particularly useful if statistical quality control is used to measure quality.

Computer Assisted Manufacturing (CAM)

CAM allows computers to design linked production processes to control machine tools and control the movement and tracking of materials during manufacturing. In their most fully integrated form, CAM systems can be linked together into a Computer Integrated Manufacturing (CIM) production process.

Computer Integrated Manufacturing (CIM)

With CIM, a computer integrates and optimizes all aspects of a company's manufacturing operations: design, inventory control, production/process control, testing, packaging and warehousing.

Computer Numeric Control (CNC)

With CNC, computers are embedded in specific machines on the factory floor, such as multiple-axis lathes, drills and cutters. These machines are programmable, enabling the operator to enter different requirements of the machining process at the computer console. These machines, which traditionally operate from paper or magnetic tapes, now run completely electronically from the computer. Once a machine is programmed, the operator can be freed up to run more than one machine at a time.

Digitizing

Digitizing is the conversion of actual dimensions of physical objects into digital signals. The object is scanned or physically measured and its properties are stored in the computer. This creates a mathematical model of the object. Modifications to its dimensions can be made before the object is printed or physically reconstructed.

Direct Numeric Control (DNC)

This is the latest generation of Computer Numeric Controlled (CNC) machines. DNC links several NC or CNC machines through a central computer that controls different tools and production equipment simultaneously. This reduces the number of stand-alone computers on the factory floor and allows the one central computer to co-ordinate all functions.

Electronic Data Interchange (EDI)

EDI is the transfer of data in electronic packages through available telecommunication channels, such as modems. EDI is typically used to automatically order raw materials from suppliers at the appropriate re-order point, receive customer orders, prepare customs documents, generate invoices and send or receive "chequeless" payments electronically. EDI is an example of a linking technology.

Just-in-Time (JIT)

JIT is an approach to inventory control where raw materials are stocked at their lowest possible levels, but are available "just in time" for the manufacturing process. Computers track the actual inventory level and maintain minimal stock levels without safety stock. When the re-order point is hit, an order (often using EDI) is placed for very fast delivery. An excellent working relationship with a reliable supplier is key to JIT's success.

Laboratory Sample Control

Computers are used to inspect or test product samples and then store data about the sample results. The process can be completely automated and eliminates physical record—keeping, with all the sample results being registered, tracked and reported by the computer.

Manufacturing Resource Planning (MRP II)

MRP II incorporates the older version of Material Resources Planning (MRP) with production scheduling and all affiliated accounting modules. MRP II helps manage inventories by anticipating their use through orders and bill-of-material explosions. The system times the purchase or fabrication of specific items in the bill-of-materials to synchronize with that product's master production schedule.

Programmable Controllers

This is the simplest form of automated production control. The controllers accept input from paper tapes, magnetic tapes and floppy disks. These programs contain numeric data which

tell the machine what function to perform. In many cases, instruction preparation takes place in equipment away from the factory floor.

Robotics - Simple

Typically, this describes the use of a programmable, stationary robotic arm to manipulate material or to provide essentially a single, but difficult function (such as spray painting or handling hazardous material).

Robotics - Complex

Complex robotics have features or abilities such as, multiple arms, robotic vision, artificial intelligence for limited decision-making and movement. (Examples include automated grading/sorting robots or trackless non-fixed route automated guide vehicles.)

Sensor-Based Systems

This is the use of automatic sensors linked to computers to display information to the human operator or computer controller. An example is an on-line pH analyzer which monitors the acidity of a solution flowing past the sensor. The signal is relayed to the computer which plots a graph of the information for the controller. The controller takes any corrective action necessary to maintain the process at equilibrium. This is an important means of closing the control loop. A fully closed-loop system will not require an operator to take corrective action.

Statistical Process Control (SPC)

SPC inspects products while they are being produced. Regular samples of the output of a production process are taken and inspected. The results are compared to the statistical tolerance limits. If there is an indication that the process quality characteristics have changed, the process is stopped, the cause is determined and corrections are made immediately. SPC builds quality in during production, as opposed to taking statistical sampling of lots after the process is complete.

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APPENDIX A

AMT APPLICATIONS FOR SIX INDUSTRY GROUPINGS

The six worksheets presented in this appendix are for your use in Phase I, Step 5, in identifying those AMT applications that are particularly effective in realizing the five indicators of competitiveness included in the table. They represent the six target industries of this guide:

- electronics
- forestry products
- metal fabrication
- non-metal fabrication
- machinery
- food products.

The circles which appear in the table are relative values that indicate the likelihood that a particular AMT, listed at the left, will assist you in achieving the five goals fro the indicators of competitiveness, listed across the columns. The circles in the table are shown in three shadings, representing:

(White) This application will not substantially help meet the noted goal

(Grey) This application can help meet the noted goal, either directly or as a by-product of meeting another goal

(Black) This application will substantially help achieve the noted goal.

These relative scores will indicate the AMT applications most useful in achieving specific goals. These tables are designed to illustrate the AMTs that are best in a given situation. The tables are by no means exhaustive or conclusive. When completing them, add other AMT applications specific to your industry. You may also wish to change some values if, in your judgement, the application is not valued appropriately for your company.

If your company has a particular need that has not been given a high value on this worksheet, check it anyway. Also, bring forward any ideas of your own that were not reflected in this worksheet. Your judgement is still the best indicator of your needs.

DATE _____

LIST OF AMT APPLICATIONS
ELECTRONICS

AMT APPLICATION	INDICATOR OF COMPETITIVENESS					
	EFFICIENCY	FLEXIBILITY	QUALITY	INNOVATION	DEPENDABILITY	✓
PRIORITY →						
PRODUCT/PROCESS DESIGN						
- Computer Aided Drafting	●	●	○	●	○	
- Computer Aided Design (CAD)	●	●	●	●	○	
- Computer Aided Process Planning (CAPP)	●	●	○	●	○	
- Computer Aided Engineering (CAE)	●	●	●	●	○	
- Artificial Intelligence	○	○	●	○	○	
PRODUCTION PROCESS						
- Programmable Controllers	○	○	○	○	○	
- Computer Numeric Control (CNC)	○	○	●	○	○	
- Direct Numeric Control (DNC)	○	○	●	○	○	
- Robotics - Simple	○	○	●	○	●	
- Robotics - Complex	○	●	●	○	●	
- Photo Lithography	○	●	●	○	○	
- Board Assembly	●	○	●	○	●	
- Computer Aided Manufacturing (CAM)	●	●	●	○	○	
- Bar Coded Data Collection	○	○	○	○	○	
- Computer Integrated Manufacturing (CIM)	●	●	●	○	○	
PROCESS CONTROL						
- Sensor-Based Systems	○	○	○	○	○	
QUALITY ASSURANCE						
- Computer Aided Inspection (CAI)	○	○	●	○	●	
- Computer Aided Testing (CAT)	○	○	●	○	●	
PLANNING						
- Manuf. Resource Planning (MRP II)	●	○	○	○	○	
- Just In Time (JIT)	●	○	○	○	○	
INFORMATION TECHNOLOGIES						
- Electronic Data Interchange (EDI)	○	○	○	○	○	
OTHER						
- Statistical Process Control	○	○	●	○	○	

DATE _____

LIST OF AMT APPLICATIONS
FORESTRY PRODUCTS

AMT APPLICATION	INDICATOR OF COMPETITIVENESS					
	EFFICIENCY	FLEXIBILITY	QUALITY	INNOVATION	DEPENDABILITY	✓
PRIORITY →						
PRODUCT/PROCESS DESIGN						
- Computer Aided Drafting	○	●	○	○	○	
- Computer Aided Design (CAD)	○	●	○	○	○	
- Computer Aided Process Planning (CAPP)	●	○	○	●	●	
- Computer Aided Engineering (CAE)	○	●	○	●	○	
- Artificial Intelligence	○	○	●	○	○	
PRODUCTION PROCESS						
- Programmable Controllers	○	○	●	○	○	
- Computer Numeric Control (CNC)	●	●	●	●	○	
- Direct Numeric Control (DNC)	●	●	●	●	○	
- Simple Robotics	○	○	○	○	●	
- Complex Robotics	○	○	●	●	○	
- Computer Aided Manufacturing (CAM)	●	●	●	●	○	
- Bar Coded Data Collection	○	○	○	○	○	
- Computer Integrated Manufacturing (CIM)	●	●	●	○	○	
PROCESS CONTROL						
- Sensor-Based Systems	○	○	○	○	○	
QUALITY ASSURANCE						
- Computer Aided Inspection (CAI)	○	○	●	○	○	
- Computer Aided Testing (CAT)	○	○	●	○	○	
PLANNING						
- Manuf. Resource Planning (MRP II)	○	●	○	○	●	
- Just In Time (JIT)	○	●	○	○	●	
INFORMATION TECHNOLOGIES						
- Electronic Data Interchange (EDI)	○	○	○	●	○	
- Laboratory Sample Control	○	○	●	○	○	
OTHER						
- Statistical Process Control	○	○	●	○	○	

DATE _____

LIST OF AMT APPLICATIONS
METAL FABRICATION

AMT APPLICATION	INDICATOR OF COMPETITIVENESS					
	EFFICIENCY	FLEXIBILITY	QUALITY	INNOVATION	DEPENDABILITY	✓
PRIORITY →						
PRODUCT/PROCESS DESIGN						
- Computer Aided Drafting	●	●	○	●	○	
- Computer Aided Design (CAD)	○	●	●	●	○	
- Computer Aided Process Planning (CAPP)	●	●	○	●	○	
- Computer Aided Engineering (CAE)	●	●	●	●	○	
- Artificial Intelligence	○	○	●	○	○	
PRODUCTION PROCESS						
- Programmable Controllers	○	○	○	○	○	
- Computer Numeric Control (CNC)	●	●	●	○	●	
- Direct Numeric Control (DNC)	●	●	●	○	●	
- Robotics - Simple	○	○	○	○	●	
- Robotics - Complex	○	●	●	○	●	
- Computer Aided Manufacturing (CAM)	●	●	●	○	○	
- Bar Coded Data Collection	○	○	○	○	○	
- Computer Integrated Manufacturing (CIM)	●	●	●	○	○	
- Digitizing	○	○	○	●	○	
PROCESS CONTROL						
- Sensor-Based Systems	○	○	○	○	○	
QUALITY ASSURANCE						
- Computer Aided Inspection (CAI)	○	○	●	○	●	
- Computer Aided Testing (CAT)	○	○	●	○	●	
PLANNING						
- Manuf. Resource Planning (MRP II)	●	○	○	○	○	
- Just In Time (JIT)	●	○	○	○	○	
INFORMATION TECHNOLOGIES						
- Electronic Data Interchange (EDI)	○	○	○	○	○	
OTHER						
- Statistical Process Control	○	○	●	○	○	

DATE _____

LIST OF AMT APPLICATIONS
NON-METAL FABRICATION

AMT APPLICATION	INDICATOR OF COMPETITIVENESS					
	EFFICIENCY	FLEXIBILITY	QUALITY	INNOVATION	DEPENDABILITY	✓
PRIORITY →						
PRODUCT/PROCESS DESIGN						
- Computer Aided Drafting	●	●	○	●	○	
- Computer Aided Design (CAD)	○	●	●	●	○	
- Computer Aided Process Planning (CAPP)	●	●	○	●	○	
- Computer Aided Engineering (CAE)	●	●	●	●	○	
- Artificial Intelligence	○	○	●	○	○	
PRODUCTION PROCESS						
- Programmable Controllers	○	○	○	○	○	
- Computer Numeric Control (CNC)	●	○	●	○	○	
- Direct Numeric Control (DNC)	●	○	●	○	○	
- Robotics - Simple	○	○	○	○	●	
- Robotics - Complex	○	●	○	○	●	
- Computer Aided Manufacturing (CAM)	●	●	●	○	○	
- Bar Coded Data Collection	○	○	○	○	○	
- Computer Integrated Manufacturing (CIM)	●	●	●	○	○	
PROCESS CONTROL						
- Sensor-Based Systems	○	○	○	○	○	
QUALITY ASSURANCE						
- Computer Aided Inspection (CAI)	○	○	●	○	●	
- Computer Aided Testing (CAT)	○	○	●	○	●	
PLANNING						
- Manuf. Resource Planning (MRP II)	●	○	○	○	○	
- Just In Time (JIT)	●	○	○	○	○	
INFORMATION TECHNOLOGIES						
- Electronic Data Interchange (EDI)	○	○	○	○	○	
OTHER						
- Statistical Process Control	○	○	●	○	○	

DATE _____

LIST OF AMT APPLICATIONS
MACHINERY

AMT APPLICATION	INDICATOR OF COMPETITIVENESS					
	EFFICIENCY	FLEXIBILITY	QUALITY	INNOVATION	DEPENDABILITY	✓
PRIORITY →						
PRODUCT/PROCESS DESIGN						
- Computer Aided Drafting	●	●	○	●	○	
- Computer Aided Design (CAD)	●	●	●	●	○	
- Computer Aided Process Planning (CAPP)	●	●	○	●	○	
- Computer Aided Engineering (CAE)	●	●	●	●	○	
- Artificial Intelligence	○	○	●	○	○	
PRODUCTION PROCESS						
- Programmable Controllers	○	○	○	○	○	
- Computer Numeric Control (CNC)	●	●	●	○	○	
- Direct Numeric Control (DNC)	●	●	●	○	○	
- Robotics	○	○	○	○	●	
- Computer Aided Manufacturing (CAM)	●	●	●	○	○	
- Bar Coded Data Collection	○	○	○	○	○	
- Computer Integrated Manufacturing (CIM)	●	●	●	○	○	
- Digitizing	○	○	○	●	○	
PROCESS CONTROL						
- Sensor-Based Systems	○	○	○	○	○	
QUALITY ASSURANCE						
- Computer Aided Inspection (CAI)	○	○	●	○	●	
- Computer Aided Testing (CAT)	○	○	●	○	●	
PLANNING						
- Manuf. Resource Planning (MRP II)	●	○	○	○	○	
- Just In Time (JIT)	●	○	○	○	○	
INFORMATION TECHNOLOGIES						
- Electronic Data Interchange (EDI)	○	○	○	○	○	
OTHER						
- Statistical Process Control	○	○	●	○	○	
- Automated Palletizer	○	○	○	○	○	

DATE _____

LIST OF AMT APPLICATIONS
FOOD PRODUCTS

AMT APPLICATION	INDICATOR OF COMPETITIVENESS					
	EFFICIENCY	FLEXIBILITY	QUALITY	INNOVATION	DEPENDABILITY	✓
PRIORITY →						
PRODUCT/PROCESS DESIGN						
- Computer Aided Drafting	○	○	○	○	○	
- Computer Aided Design (CAD)	○	○	○	○	○	
- Computer Aided Process Planning (CAPP)	●	○	○	●	○	
- Computer Aided Engineering (CAE)	○	○	○	○	○	
- Artificial Intelligence	○	○	●	○	○	
PRODUCTION PROCESS						
- Programmable Controllers	○	○	○	○	○	
- Computer Numeric Control (CNC)	○	○	●	○	○	
- Direct Numeric Control (DNC)	○	○	●	○	○	
- Robotics - Simple	●	●	○	○	●	
- Robotics - Complex	○	○	○	○	●	
- Computer Aided Manufacturing (CAM)	●	●	●	○	○	
- Bar Coded Data Collection	○	○	○	○	○	
- Computer Integrated Manufacturing (CIM)	●	●	●	○	○	
PROCESS CONTROL						
- Sensor-Based Systems	○	○	○	○	○	
QUALITY ASSURANCE						
- Computer Aided Inspection (CAI)	○	○	●	○	●	
- Computer Aided Testing (CAT)	○	○	●	○	●	
PLANNING						
- Manuf. Resource Planning (MRP II)	●	○	○	○	○	
- Just In Time (JIT)	●	○	○	○	○	
INFORMATION TECHNOLOGIES						
- Electronic Data Interchange (EDI)	○	○	○	○	○	
OTHER						
- Statistical Process Control	○	○	●	○	●	
- Automated Packaging	●	○	○	○	○	

APPENDIX B

AMT ECONOMIC ANALYSIS

BENEFITS DETAIL WORKSHEETS

AMT ECONOMIC ANALYSIS - BENEFITS DETAIL WORKSHEETS

Benefits related to AMT applications and technology projects are either quantitative or qualitative.

Quantitative benefits include those direct benefits to which a dollar value can be easily assigned, such as reduced direct labour costs, reduced indirect labour costs, reduced inventory carrying costs and reduced wastage. Quantitative benefits also include indirect benefits to which a dollar value can be assigned with some effort and research. These include improved ability to comply to government regulation, reduced need for workers to handle hazardous wastes, faster manufacturing or processing cycles, reduction in scrap or higher manufacturing or processing yields.

Qualitative benefits are not readily definable in dollar terms. They are related to "quality" improvements, such as faster responses to customer requests, improved customer service, improved staff morale or increased safety.

The following checklists provide examples of quantitative and qualitative benefits which may apply to your manufacturing or processing environment. A suggested method for calculating the benefit is provided where one is appropriate.

In addition to selecting items from the lists, add other items that are specific to your manufacturing or processing environment and enter them on the AMT Economic Analysis Benefits Detail Worksheet in this appendix. It is likely that all the information you require will not be immediately available. If necessary, estimate the benefits as best as you can to keep the process going.

The total benefits figures generated from this procedure are entered on the AMT Economic Analysis Cost/Benefit Summary Worksheet in Appendix D.

QUANTITATIVE BENEFITS

Direct Benefits

Labour Savings

These savings represent a reduction in the time and effort required to perform given tasks, such as:

- setup
- drafting/design
- design
- assembly
- inspection
- distribution of materials
- supervision.

Note that this type of benefit is realized in cash terms only when labour is reduced as a result of technology implementation. However, the benefits should still be evaluated as if they were actual cash savings, presuming hourly paid employees, not salaried staff.

Number of workers affected by AMT	X	Avg. Annual Wage & Benefits per Worker Impacted by AMT	X	% Improvement in Productivity after AMT implementation	=	Labour Cost Saving ($)

Depending on the AMT to be implemented, the labour cost saving may only be realized over several years. Therefore, it may be necessary to estimate the projected labour cost savings to complete the benefits worksheet.

Other Direct Benefits

These are tangible, easily quantified costs that are currently budgeted and which will be either completely avoided, or replaced by costs allocated to the AMT project. They include:

- Overtime pay
- Postage/courier
- Telephone
- Printing services
- Equipment rental
- Equipment repair
- Equipment purchase
- Reduced inventory (raw, work in process, finished) carrying costs
- Less need for safety stock
- Reduced scrap
- Improved yields
- Reduced manufacturing or processing cycle time
- Reduced travel time
- Reduced insurance costs
- Improved ability to comply with government regulations
- Reduced necessity to handle hazardous wastes
- Reduced energy consumption.

Direct benefits can be quantified in the follow manner:

Current budgeted amount for direct benefit	X	Anticipated % Savings as a result of AMT	=	Direct Savings ($)

These direct savings, estimated over several years if applicable, should be included in the benefits worksheet.

Indirect Benefits

These are tangible, but not easily quantified costs that are currently budgeted and which will either be completely avoided or replaced by costs allocated to the AMT project. However, while information about various AMT applications is being collected, softer costs can sometimes be quantified. Some examples of these costs include:

- Administrative costs
- Training services
- Accommodations
- Inspection services
- Volume of wastage
- Supervision
- Transportation costs
- Rework effort
- Improved flexibility
- Improved control of specifications
- Enhanced traceability
- Activity based accounting
- Increased time for planning and training
- Improved safety and therefore fewer costly accidents
- Lower employee turnover
- Lower absenteeism
- More available floor space
- Faster product introduction
- Renting or selling AMT technology to other firms.

Indirect benefits, which are inherently much more difficult to quantify, can be assessed using the following formula:

Actual or budgeted amount for indirect benefit	X	Anticipated % Savings as a result of AMT	=	Indirect Savings ($)

These indirect savings, estimated over several years if applicable, should be included in the benefits worksheet.

QUALITATIVE BENEFITS

Qualitative benefits normally relate to performing given tasks more effectively. These benefits are not easy to quantify, but must be reflected in your AMT investment justification document as part of the Final Evaluation Table (Exhibit 8). Examples of qualitative benefits include:

Management

- More effective management
- Better decision-making
- Better scheduling/workflow
- Increased ability to focus on revenue-generating activities
- Less risk of obsolete material
- More productive management
- More predictable performance

Employees

- Reduced stress
- Better quality of work life
- Experience with new technology
- Higher learning rate
- Improved morale
- Less fatigue
- Less resistance to other new projects
- More motivated workforce

Production Facility

- Ease of accommodating design changes
- Less clutter, improved appearance of shop floor
- More disciplined manufacturing or processing processes

Customer

- Reduction of back-logged work
- Improved competitive position, new market opportunities
- Better client service
- Faster deliveries
- Improved product quality and consistency
- Faster product introduction
- Improved product reliability
- Improved relations with suppliers and customers
- Increased responsiveness to market conditions.

AMT ECONOMIC ANALYSIS
BENEFITS DETAIL WORKSHEET
APPLICATION: _____

QUANTITATIVE BENEFITS ($000s)

		Yr. 1 19__	Yr. 2 19__	Yr. 3 19__	Yr. 4 19__	Yr. 5 19__	Total
Labour Savings							
1.	_____	____	____	____	____	____	____
2.	_____	____	____	____	____	____	____
3.	_____	____	____	____	____	____	____
4.	_____	____	____	____	____	____	____
5.	_____	____	____	____	____	____	____
Direct Savings							
6.	_____	____	____	____	____	____	____
7.	_____	____	____	____	____	____	____
8.	_____	____	____	____	____	____	____
9.	_____	____	____	____	____	____	____
Indirect Savings							
10.	_____	____	____	____	____	____	____
11.	_____	____	____	____	____	____	____
12.	_____	____	____	____	____	____	____
13.	_____	____	____	____	____	____	____
TOTAL BENEFITS		____	____	____	____	____	____

APPENDIX C

AMT ECONOMIC ANALYSIS

COST DETAIL WORKSHEETS

AMT ECONOMIC ANALYSIS - COST DETAIL WORKSHEETS

Costs related to AMT applications are either one-time costs or ongoing costs. The lists included in this appendix are provided to assist you in identifying potential cost categories that may apply to your manufacturing or processing environment. In addition, a method to derive each cost figure is suggested. These lists are not intended to be complete; they should be augmented with specific cost items relevant to your industry and company.

Select the cost items that apply to your manufacturing or processing environment and enter them on the AMT Economic Analysis Cost Detail Worksheet that appears in this appendix. The total one-time and ongoing cost figures will be entered on the AMT Economic Analysis Cost/Benefit Summary Worksheets provided in Appendix D. In many instances, the cost information may not be readily available and this cost worksheet should used as a reminder to gather the additional data required.

Bear in mind that tax considerations and the availability of financial assistance through government can significantly affect your costs. For example, accelerated depreciation (or Capital Cost Allowance) related to certain capital acquisitions is not in itself a cash flow. However, it has an affect on cash flow by reducing the tax paid. This tax saving is sometimes called the CCA Tax Shield or the Depreciation Tax Shield. You should discuss the concept of Depreciation Tax Shields with your accountant or financial advisor in order to accurately reflect this valuable cost reduction in your cost estimates. Tax savings can influence the economic viability of a particular investment alternative.

In addition, if AMT is sufficiently innovative and has been developed in-house, specific R&D tax credits may be available that will reduce the AMT's outright cost.

For complete details on how to estimate and quantify possible cost reductions associated with accelerated depreciation rules, contact your tax advisor or Revenue Canada, Taxation. For further information on tax treatment of AMT investments, R&D tax credits or available government assistance, you should contact your accountant, Revenue Canada, or a representative of Industry, Science and Technology Canada.

ONE-TIME COSTS

These are costs incurred once during the implementation period, such as:

PURCHASES AND CAPITAL COSTS	**ESTIMATION**
Hardware and Equipment	# units X $/unit
Software	# units X $/unit
Communications Equipment	# units X $/unit
Furniture	# units X $/unit
Site Preparation	$ estimate

PROFESSIONAL SERVICES, LABOUR COSTS	**ESTIMATION**
Project Management	# days X $/day or $ estimate
Analysis, Design, Technical Specifications	# days X $/day or $ estimate
Engineering Costs	# days X $/day or $ estimate
Specialist Services	# days X $/day or $ estimate
- integration, installation, testing, evaluation, etc	
Other Consulting Services	# days X $/day or $ estimate
Programming, Setup	# days X $/day or $ estimate
Data Conversion	# days X $/day or $ estimate
Travel	$ estimate or # trips x $/trip
Staff Training	
Internal:	Trainers: # hrs X $/hr Trainees: # hrs X $/hr Materials $ $ Course Fees
External:	
Administrative Support	# hrs X $/hr
Operations Services	# hrs X $/hr

ONGOING COSTS

These are costs that are incurred each month or year after the AMT application is installed. The level of these costs may vary depending on the phase of implementation or they remain constant over an indefinite period.

Select the appropriate categories for your company from the list of ongoing costs provided. Be sure to augment your selections with other specific costs that relate to your manufacturing or processing environment. Include all your costs on the AMT Economic Analysis Cost Detail Worksheet in this Appendix. Calculate all figures on an annual basis.

MAINTENANCE	**ESTIMATION**
Hardware and equipment	$ per unit/year x # units
Software Licences	$ per product/year x # products
Upgrades	$ per product/year x # products

LEASES	
Hardware and equipment	$ per unit/year x # units
Communications network	$ per unit/year x # units
Software	$ per unit/year x # units
Physical Space	$ per sq. metre/year

OPERATIONS	
Production Labour Costs	# hrs x $/hr
Management Labour Costs	# hrs x $/hr
Supervision Labour Costs	# hrs x $/hr
Security	$ estimate
Inspection Costs	# hrs x $/hr

OTHER	
Transportation Costs	$ estimate
Data Communications Costs	# usage units x $/unit or # usage units x $/unit
Utility & misc. costs (power, water, etc.)	$/month
Off-site storage	$ sq. metre or $/month flat rate
Insurance	$ estimate
Ongoing Training	# hrs X $/hr and $ estimate

AMT ECONOMIC ANALYSIS
COST DETAIL WORKSHEET
APPLICATION: _____

ESTIMATED ANNUAL COSTS ($000s)

A. ONE-TIME COSTS:

		Yr. 1 19__	Yr. 2 19__	Yr. 3 19__	Yr. 4 19__	Yr. 5 19__	Total
Purchases and Capital Costs							
1.	_____	____	____	____	____	____	____
2.	_____	____	____	____	____	____	____
3.	_____	____	____	____	____	____	____
4.	_____	____	____	____	____	____	____
5.	_____	____	____	____	____	____	____
6.	_____	____	____	____	____	____	____
7.	_____	____	____	____	____	____	____
8.	_____	____	____	____	____	____	____
9.	_____	____	____	____	____	____	____
10.	_____	____	____	____	____	____	____
11.	_____	____	____	____	____	____	____
12.	_____	____	____	____	____	____	____
13.	_____	____	____	____	____	____	____
Sub-total, Purchases and Capital Costs		____	____	____	____	____	____

AMT ECONOMIC ANALYSIS
COST DETAIL WORKSHEET
APPLICATION: _____

A. ONE-TIME COSTS ($000s) (Cont'd)

	Yr. 1 19__	Yr. 2 19__	Yr. 3 19__	Yr. 4 19__	Yr. 5 19__	Total
Professional Services, Labour Costs, Other Support						
1. _____	____	____	____	____	____	____
2. _____	____	____	____	____	____	____
3. _____	____	____	____	____	____	____
4. _____	____	____	____	____	____	____
5. _____	____	____	____	____	____	____
6. _____	____	____	____	____	____	____
7. _____	____	____	____	____	____	____
8. _____	____	____	____	____	____	____
9. _____	____	____	____	____	____	____
10. _____	____	____	____	____	____	____
11. _____	____	____	____	____	____	____
12. _____	____	____	____	____	____	____
SUB-TOTAL ONE-TIME COSTS	____	____	____	____	____	____
LESS:						
DEPRECIATION TAX SHIELD	(____)	(____)	(____)	(____)	(____)	(____)
TOTAL ONE-TIME COSTS	____	____	____	____	____	____

AMT ECONOMIC ANALYSIS
COST DETAIL WORKSHEET
APPLICATION: _____

B. ONGOING COSTS ($000s)

		Yr. 1 19__	Yr. 2 19__	Yr. 3 19__	Yr. 4 19__	Yr. 5 19__	Total
Maintenance							
1.	_____	____	____	____	____	____	____
2.	_____	____	____	____	____	____	____
3.	_____	____	____	____	____	____	____
Leases							
4.	_____	____	____	____	____	____	____
5.	_____	____	____	____	____	____	____
6.	_____	____	____	____	____	____	____
Operations							
7.	_____	____	____	____	____	____	____
8.	_____	____	____	____	____	____	____
9.	_____	____	____	____	____	____	____
Other							
10.	_____	____	____	____	____	____	____
TOTAL ONGOING COSTS		____	____	____	____	____	____

APPENDIX D

AMT ECONOMIC ANALYSIS

COST/BENEFIT SUMMARY WORKSHEET

AMT ECONOMIC ANALYSIS - COST BENEFIT SUMMARY WORKSHEET

Appendix B provided an assessment of benefits that can be expected from investing in AMT, including those which are quantitative (labour, direct and indirect) and qualitative (improved morale, better client service, etc.).

In Appendix C, the various costs (both one-time and recurring) associated with AMT applications were estimated and calculated.

The following sections are designed to assist you in consolidating this quantitative information into a "Cost/Benefit Analysis." This analysis then becomes the basis for the Economic Cost/Benefit assessment on the Final Evaluation Table (Exhibit 8) in Step 9.

Cost/Benefit analyses can vary greatly in complexity, depending on the magnitude of the project being considered. For this guide, a simple, step-by-step method of preparing such an analysis is provided; this method can be modified or expanded to suit your particular needs.

> **Note: Refer to the AMT Economic Analysis Cost/Benefit Summary Worksheet provided in this appendix while reading the following paragraphs.**

TECHNIQUES TO SUMMARIZE THE INVESTMENT INFORMATION

1. Calculate the Benefits and Costs

Begin your cost/benefit analysis by preparing a list of the benefits you expect to gain from your proposed project. Then, calculate the dollar value of those benefits on a year-by-year basis using the worksheets in Appendix B. Typically, investments of this type are assessed over a five year period.

After estimating value of the total benefits you anticipate from the project, calculate the costs. Begin by preparing a complete list of costs that will be incurred, using the worksheets in Appendix C. Assign the appropriate dollar values to these costs on a year-by-year basis.

2. Calculate the Total Benefits and Costs

Once the costs and benefits are calculated, you can then summarize your findings and analyze them further. To do so:

a) Transcribe the Total Benefits (for each year of the project) from the AMT Economic Analysis Benefits Detail Worksheet to line 1 of the Cost/Benefit Summary Worksheet in this appendix

b) Transcribe the Total One Time and Ongoing Costs (for each year of the project) from the Economic Analysis Cost Detail Worksheet to lines 3 and 4 of the Summary Worksheet in this appendix

c) Calculate the Total Costs for all years on line 5.

3. Calculate the Cumulative Benefits and Costs

The Total Benefits and Total Costs should also both be added **cumulatively** on a year-by-year basis, and entered on lines 2 and 6. For example,

Yr. 3 Total Benefits (Cumulative)
= Yr. 1 Total Benefits + Yr. 2 Total Benefits + Yr. 3 Total Benefits

4. Calculate the Net Comparison of Benefits to Costs

Calculate the dollar value difference between Benefits and Costs on a year-by-year basis, and enter it on line 7. For example:

(line 1 - line 5) = line 7
or (Total Benefits Yr. 1) - (Total Costs Yr. 1) = Benefits - Costs

Calculate the dollar value difference between Cumulative Benefits and costs on a year-by-year basis, and enter it on line 8. For example:

(line 2 - line 6) = line 8
or (Total Cumulative Benefits Yr. 1) - (Total Cumulative Costs Yr. 1) = Cumulative Benefits - Costs

5. Calculate the Year of Payback

The year of payback for your AMT investment is the point when the ratio of cumulative benefits to cumulative costs is greater than 1.

Calculate the ratio of total benefits to costs for each year, and enter it on lines 9 and 10. For example:

$$\frac{\text{(line 1)}}{\text{(line 5)}} = \text{line 9 or } \frac{\text{Total Benefits Yr. 1}}{\text{Total Costs Yr. 1}} = \text{Benefits/Costs}$$

and

$$\frac{\text{(line 2)}}{\text{(line 6)}} = \text{line 10 or } \frac{\text{Total Cumulative Benefits Yr. 1}}{\text{Total Cumulative Costs Yr. 1}} = \text{Cumulative Benefits/Costs}$$

For example, if the cumulative ratios are:

Yr. 1 = .07
Yr. 2 = .24
Yr. 3 = .44
Yr. 4 = .87
Yr. 5 = 1.32

The payback would occur in the project's fifth year because the ratio is greater that 1. Enter the result of 5 on line 11.

6. Calculate the Net Present Value

"Net Present Value" analysis is a technique that takes into account the changing value of money over time.

For example, money can be invested to earn interest. Therefore, it would be more desirable to receive $100 today than it would to receive $100 one year from now. This is because, if you invested your $100 today at 10 percent interest, the money would be worth $110 in one year. Conversely, $100 received one year from now would have a present value of $90.91, because that is the amount which, if invested today at 10 per cent, would yield $100 in one year's time.

As a rule, investors do consider the time value of money when making a decision. Present value analysis enables costs and benefits that will occur in the future to be compared at one point in time: the present. Using the Net Present Value Method all cash flows are discounted to present value using the required rate of return or "hurdle rate". This hurdle rate is the minimum acceptable rate of return you will accept on a project. It can be based on the rate of interest you can earn from the bank, the average return you have realized on similar investments, your average cost of capital, or can be completely arbitrary. Should you require assistance in calculating your hurdle rate consult your accountant or financial adviser.

The following approach assumes that you have a business calculator available with a built-in NPV function. You will need to enter the following information:

- Cf_o - the initial investment amount (usually negative) or the benefits - cost amount for the first year.
- Cf_n - the unequal consecutive cash flows (benefits - costs) for each of the "n" years being included in the economic analysis.
- i - required rate of return or "hurdle rate".

An example of the NPV calculation on line 13 is:

	Initial Investment	Year 1	Year 2	Year 3	TOTAL
Benefits - Costs (line 7)	($18,000)	$8,000	$6,000	$10,000	$24,000

Using the terminology stated above:

Cf_0 = ($18,000)
Cf_1 = $8,000
Cf_2 = $6,000
Cf_3 = $10,000

At a 10 percent required rate of return or "hurdle rate", the resulting NPV is $1,744.55.

The greater the Net Present Value (ie. >0), the more favourable the economic justification of your proposed project. Calculate this amount and enter it on line 13.

7. Calculate the Internal Rate of Return

A project's Internal Rate of Return is the interest rate that causes the present value of the net cash inflows (i.e. benefits - costs) to equal the initial investment. In other words, IRR is the interest rate at which the Net Present Value is equal to zero.

IRR is sometimes described as the maximum interest rate an organization would pay for the cash invested in a project without losing money.

When applying this concept to your AMT project, the higher the percentage (internal rate of return), in general, the more desirable the proposed project would be, assuming it exceeds the hurdle rate.

The following approach assumes that you have a business calculator available with a built-in IRR function. You will need to enter the following cash flow (i.e. benefits - costs) information:

Cf_0 - the initial investment amount (usually negative)

Cf_n - the unequal consecutive cash flows for each of the "n" years being included in the economic analysis.

IRR is an extremely complex calculation. Therefore, you may have to provide an estimate of IRR to simplify the process. Consult your calculator handbook or finance textbook for details.

An example of a three-year IRR calculation on line 14 is:

	Initial Investment	Year 1	Year 2	Year 3	TOTAL
Benefits - Costs (line 7)	($18,000)	$8,000	$6,000	$10,000	$24,000

Using the terminology stated above:

Cf_0 = ($18,000)
Cf_1 = $8,000
Cf_2 = $6,000
Cf_3 = $10,000

The resulting IRR = 15.2%.

Enter the IRR on line 14 of the Cost/Benefit Summary worksheet. Compare the IRR with your hurdle rate. If the IRR exceeds the hurdle rate, the AMT investment is attractive; if not, it is not attractive.

For example, if the hurdle rate were 10 percent, the investment proposal considered above with an IRR of 15.2 percent would be acceptable by itself in terms of economic cost/benefit.

AMT ECONOMIC ANALYSIS
COST/BENEFIT SUMMARY WORKSHEET
APPLICATION: _____

QUANTITATIVE BENEFITS ($000s)

	Yr. 1 19__	Yr. 2 19__	Yr. 3 19__	Yr. 4 19__	Yr. 5 19__	Total
BENEFITS						
1. Total Benefits	____	____	____	____	____	____
2. Total Cumulative Benefits	____	____	____	____	____	____
COSTS						
3. One-Time Costs	____	____	____	____	____	____
4. Ongoing Costs	____	____	____	____	____	____
5. Total Costs	____	____	____	____	____	____
6. Total Cumulative Costs	____	____	____	____	____	____
7. Benefits - Costs	____	____	____	____	____	____
8. Cumulative Benefits - Costs	____	____	____	____	____	____
9. Benefits ÷ Costs	____	____	____	____	____	____
10. Cumulative Benefits ÷ Costs	____	____	____	____	____	____

11. Payback Occurs In Year (line 10 > 1.0) _____

12. At a required rate of return or hurdle rate of: _____%

13. Net Present Value (Total P.V. of Benefits - Total P.V. of Costs) _____

14. I.R.R. (%) (Internal Rate of Return) _____

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REGISTRATION FORM

Please circle the appropriate choice to the following questions:

1. In which business sector do you operate?

   a) Electronics
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   c) Metal Fabrication
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   e) Machinery
   f) Food Products
   g) other (please specify)
   _____

2. How many employees are there in your organization?

   a) <50
   b) 50-100
   c) 100-200
   d) >200

3. How did you first hear of this guide?

   a) through advertising in local media or promotional material
   b) through a colleague, accountant, financial advisor, consultant, banker, industry association or local Chamber of Commerce
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